

**Submerged Membrane Module  
for MBR  
TORAY “MEMBRAY”**

**“TMR140 Series”  
Instruction Manual**



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## Content

I.	INTRODUCTION .....	1
1.	Features of MBR .....	1
2.	Outline of “TMR140 Series” .....	2
II.	FOR SAFE OPERATION OF “TMR140 SERIES” .....	5
1.	Unpacking and Installation .....	5
2.	Operation and Maintenance .....	6
3.	Chemical Cleaning of Element .....	7
III.	SPECIFICATIONS AND PERFORMANCE OF “TMR140 SERIES” .....	9
1.	Specifications of Element .....	9
2.	Specifications of Polyurethane Permeate Tube .....	9
3.	Specifications and Performance of “TMR140 Series” Module .....	10
IV.	MEMBRANE FILTRATION PROCESS DESIGN FOR “TMR140 SERIES” .....	12
1.	Standard Time Chart .....	12
2.	Flow Diagram of Membrane Filtration .....	13
3.	Layout of “TMR140 Series” Modules in Membrane Submerged Tank .....	18
4.	Piping .....	21
V.	INSTALLATION OF “TMR140 SERIES” .....	23
1.	Preparatory Procedure .....	23
2.	Unloading/lifting Products .....	23
3.	Checking Products .....	24
4.	Storage Products .....	24
5.	Installation Products .....	25
VI.	START OF OPERATION .....	30
1.	Clean Water Operation .....	30
2.	Seeding Sludge Injection .....	31
3.	Actual Filtration Operation .....	31
VII.	OPERATION CONTROL .....	33
1.	Standard Operating Conditions .....	33
2.	Operating Parameters .....	35
3.	Basic Control Philosophy .....	36
4.	Daily Inspection .....	37
VIII.	MAINTENANCE OF “TMR140 SERIES” .....	40
1.	Maintenance Items and Maintenance Frequency .....	40
2.	Air Diffuser Cleaning .....	41
3.	Chemical Cleaning of Element .....	43
4.	Chemical Agents Available for Chemical Cleaning .....	43
5.	Handling of Chemical Agents .....	44
6.	Chemical Cleaning Procedure .....	47
7.	Lifting Procedure .....	52

8. Storage Products after Use .....	53
9. Disposing Procedure .....	54
IX. REPLACEMENT PARTS LIST .....	55
X. TROUBLESHOOTING .....	56
XI. APPENDIX .....	57

Symbols used in this manual



**DANGER**

This symbol is used to indicate an imminent hazardous situation which, if not avoided, will result in serious injury or death.



**WARNING**

This symbol is used to indicate a potentially hazardous situation which, if not avoided, can result in serious injury or death.



**CAUTION**

This symbol is used to indicate a potentially hazardous situation which, if not avoided, may result in injury or property damage.

## I. INTRODUCTION

Toray "MEMBRAY" is the submerged membrane module suitable for the membrane bioreactor (MBR) that has been developed based on the polymer science and the membrane fabrication technologies accumulated for a long time in Toray Industries, Inc.

"TMR140 Series" is a standard model of "MEMBRAY". This manual explains MBR's features and describes the specifications of "TMR140 Series" and its safe operations including installation, operation, maintenance procedures and peripheral equipments. Operators should thoroughly read this manual to ensure stable operation.

### 1. Features of MBR

The process flow of the conventional activated sludge system (CAS) and MBR are shown in Fig.I-1 and Fig.I-2, respectively.

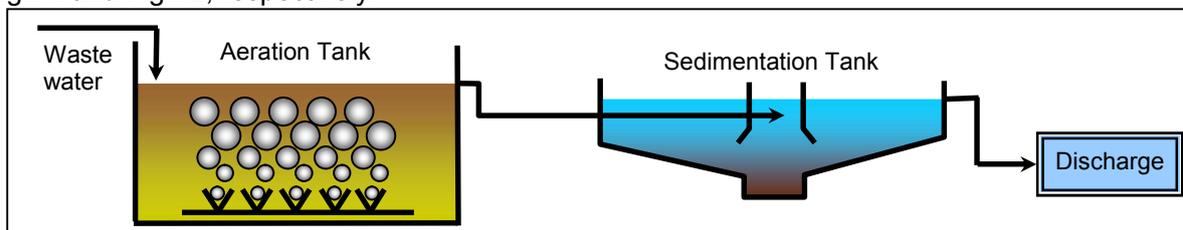


Fig. I-1 CAS Flow

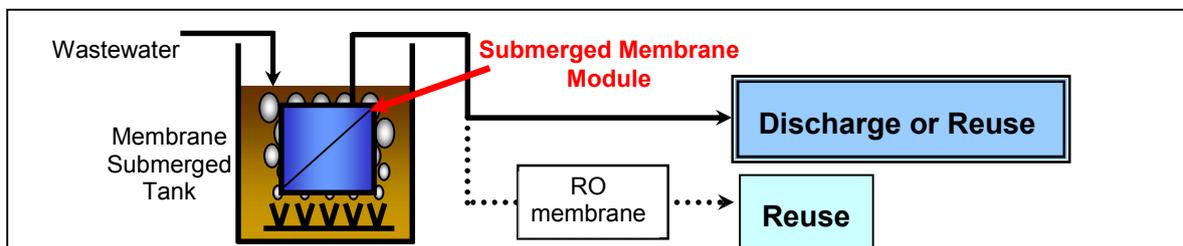


Fig. I-2 MBR Flow

MBR provides the following advantages:

#### (1) Small Footprint

Unlike CAS, MBR separates sludge within aeration tank using membranes, thus eliminating the space for preparing a sedimentation tank. Also, with membranes, MBR can hold a higher concentration of activated sludge in the aeration tank, so its volume can be reduced. As a result, MBR provides a smaller footprint compared to CAS.

#### (2) High quality of treated water

MBR removes suspended solids (SS) from the sludge liquid with membranes much more effectively than the conventional sedimentation process. MBR also rejects microorganisms such as *Escherichia coli* and *Cryptosporidium* efficiently.

## 2. Outline of “TMR140 Series”

“TMR140 Series” is the membrane module composed of the element block and the aeration block. The element block contains a number of membrane elements stacked at equal clearance, each of which has flat sheet membranes attached on both sides of ABS panel. Each element is connected via polyurethane tube to the permeated water manifold. The aeration block consists of coarse-bubble air diffusers to supply scouring air (see Fig.I-3). This module is used submerged in sludge liquid. The following shows the features of “TMR140 Series”.

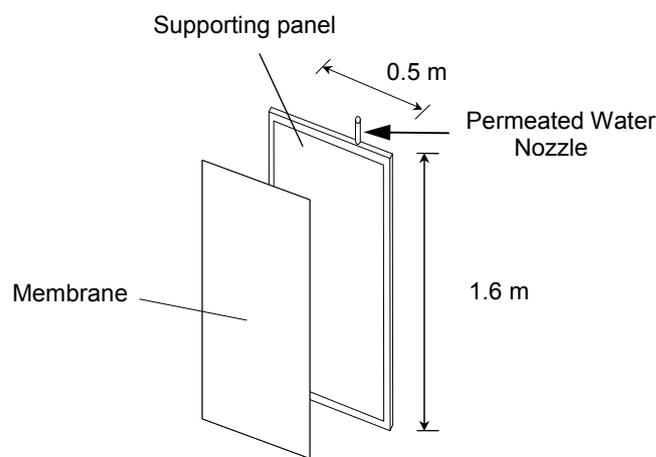


**Fig. I-3 Appearance of “TMR140-100S”**

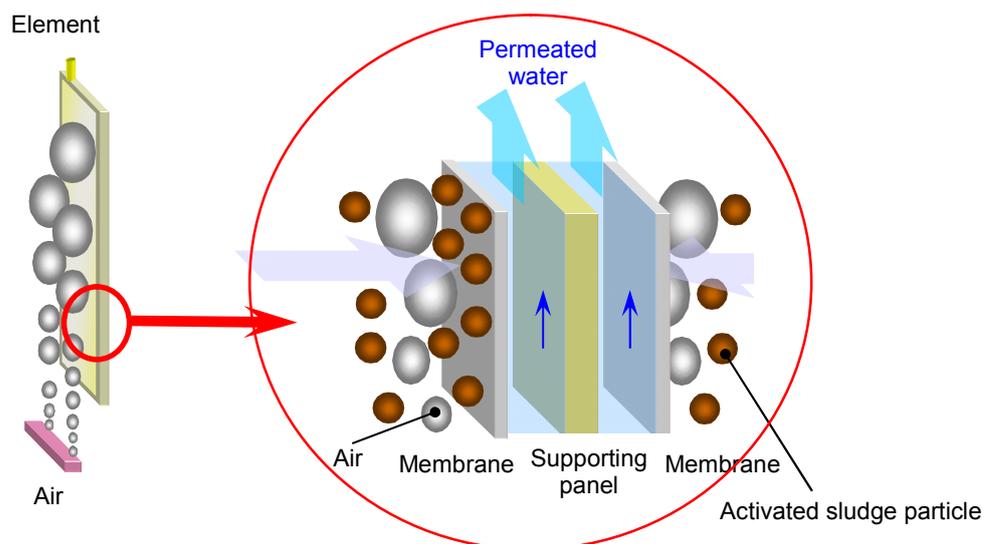
(1) Shape of Element

The membrane element is a flat sheet type as shown in Fig.I-4. At the normal filtration operation, the sludge accumulated on the membrane surface is cleaned up effectively with upward water stream generated with the scouring air supplied from the air diffusers installed at the bottom side (Fig.I-5). This mechanism ensures stable filtration, since the membrane does not easily admit of sludge adherence to its surface.

In addition, thanks to the long element design (1.6 m), a larger membrane area is achieved per footprint, allowing effective use of diffused air.



**Fig. I-4 Structure of Element**



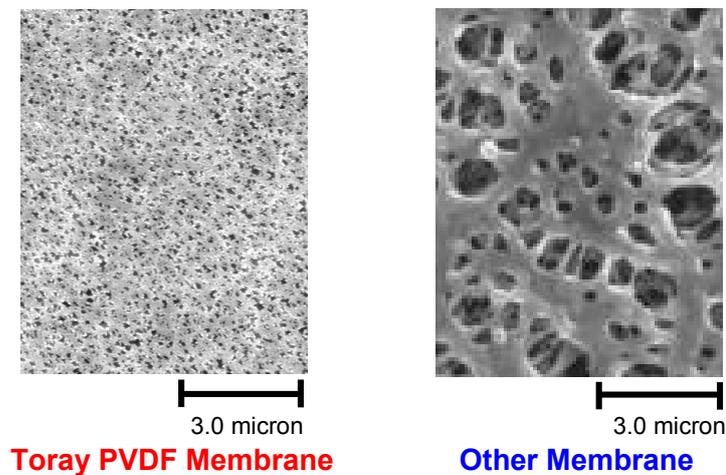
**Fig. I-5 Filtration Principle of Activated Sludge**

(2) Membrane Structure

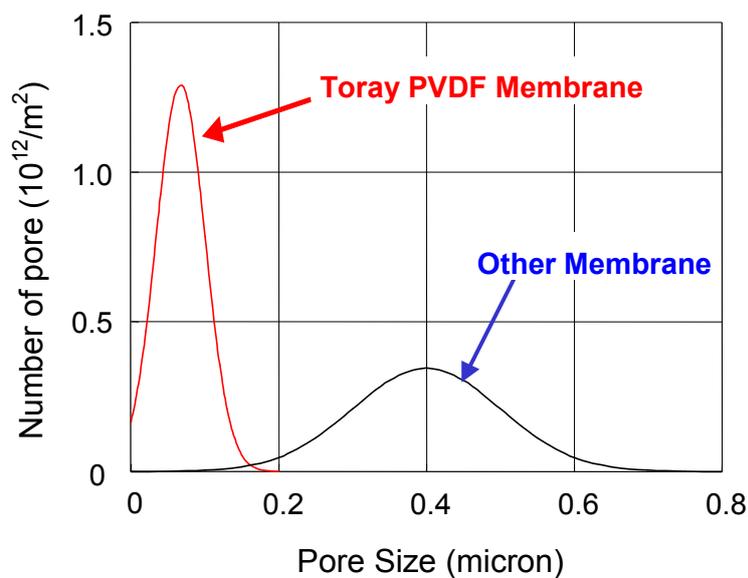
The flat sheet membrane consists of PVDF (Polyvinylidene Fluoride) functional layer and the base layer of PET (polyester) non-woven fabric. This structure gives the membrane superior physical strength and high chemical resistance.

(3) Membrane Pore Size

Numerous small-size pores are distributed evenly over the membrane surface with a sharp pore-size distribution. This structure gives an outstanding high treated water quality and an excellent water permeability, making the membrane highly resistant to clogging (see Fig.I-6 and Fig.I-7) compared to other membranes. The average pore size is 0.08 micron meter.



**Fig. I-6 Membrane Surface (photo)**



**Fig. I-7 Pore Size Distribution**

## II. FOR SAFE OPERATION OF “TMR140 SERIES”

Before using “TMR140 Series”, please thoroughly read this Instruction Manual and follow the instructions described in this manual, especially the safety precautions shown below. The details of each precaution are described in the relevant chapter

### 1. Unpacking and Installation



**DANGER**

When lifting “TMR140 Series” or its part, please attach chains or slings to it and raise it straight upward calmly to prevent it from shaking. Please never allow any person under lifted article.



**DANGER**

Please use chains or slings compatible with lifting weight when lifting “TMR140 Series” or its part.



**DANGER**

Check the condition of each part before lifting and never use damaged one. Never stand below the membrane module when lifting. Be careful of the balance of the module when lifting.



**DANGER**

When lifting TMR140-200D or 400DW, do not lift upper element blocks and lower element blocks all together. Upper/lower element block has to be lifted separately.



**DANGER**

When installing “TMR140 Series” module, please set up a foothold in advance. Never climb the module. Please use protective equipment to ensure the safety of workers.



**CAUTION**

At transportation, storage and installation, please take appropriate measures to protect “TMR140 Series” or its part from damage. Please don't put any heavy objects on the module. Please take care to protect the module from collision with other objects.



**CAUTION**

Please do not leave “TMR140 Series” for hours in the place where the temperature is higher than 40 degree C or in the place exposed to direct sunlight. Especially ABS supporting panel may be deteriorated with direct sunlight, ultraviolet ray.



**CAUTION**

Please take adequate measures to protect “TMR140 Series” from sparks caused by welding, fusion cutting or grinding throughout the entire process from installation work to operation startup.



**CAUTION**

Please protect “TMR140 Series” from freezing at any time.



**CAUTION**

Please don't pressurize the permeate side of “TMR140 Series”.



Please install the screen with openings of 3.0 mm or under before the membrane submerged tank. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

## 2. Operation and Maintenance



Don't use permeated water for drinking.



Before discharging the treated water to the environment or reusing it, make sure to analyze its quality and confirm that the water quality meets the intended purpose.



Don't burn the membranes without appropriate facilities since harmful Hydrogen fluoride (HF) gas is generated at burning. When dispose membranes, please apply a service of a qualified waste disposing company.



When the clean water operation, charging clean water to the membrane submerged tank with the air discharge valve open to release air from the elements. After charging water, close the air discharge valve.



Don't use the ground water, which contains considerable amount of iron, manganese, calcium or silica, for the clean water operation as it may cause the clogging of the membrane.



Don't continue the clean water operation unnecessarily. A long-time filtration of clean water tends to cause the clogging.



Once the membrane gets wet, keep it wet. If the wet membrane is dried up again, the permeability of the membrane might be decreased seriously.



When feeding the seeding sludge, be sure to remove foreign substances from it with the screen (with openings of 5mm or under).



Don't do the filtration operation without supplying the scouring air in a right way, or the membrane will be clogged severely.



Don't put in the activated sludge liquid chemicals, toxic agents, oils or other substances that may adversely affect activated sludge.



ABS supporting panel may get chemical cracks by some organic solvent, such as alcohols and oils, and some synthetic detergents. So don't make ABS panel contact such materials.



Please avoid abrupt changes of operating conditions, especially pH, temperature and the suction pressure of the membrane even within the range of the standard operating conditions (Table VII-1).



Please replace the renewal parts periodically or when the deterioration is detected at the inspection.



Prevent "TMR140 Series" from freezing at any time.



Please take care not to dry the membranes when taking "TMR140 Series" out of the liquid for the inspection or the maintenance. If the wet membrane is dried up again, the permeability of the membrane might be decreased seriously.



Please stop the scouring air when the filtration operation stops except for the following conditions:  
1) In case of applying intermittent filtration, do not stop the scouring air for each relaxation period.  
2) In case that the plant operation stops for a while, aeration is applicable for mixing or aeration demand, however, the flow rate should be controlled minimal.



Please don't re-use the old permeate tubes once disconnected from the nozzles since the connection tightness of the tubes are reduced.

### 3. Chemical Cleaning of Element



The chemical agents used for the chemical cleaning are harmful to the health. When handling chemicals, please read their material safety data sheet (MSDS) in advance and make sure to wear necessary protectors such as protective goggles and protective gloves.



If the chemical agents stick to your skin or clothes, immediately wash it away with enough amount of running water.



If the chemical agents enter your eyes, immediately wash it away with enough amount of running water and see the doctor.



If any abnormality is found in the equipment during chemical cleaning, immediately stop operation and check it.



If chemical is injected forcibly directly with the chemical feed pump or by any other means, the internal pressure of the elements will increase and the elements will get damaged. Be sure to inject chemical with the pressure of lower than 10 kPa (100 mbar).



When injecting the chemical agents at the chemical cleaning, please confirm beforehand that the modules are completely submerged in the liquid and the liquid level of the membrane submerged tank is higher by more than 500 mm than the top of the module.



Please store the chemical agents in a dark cold place free from direct sunlight.



Please use the appropriate tank or the container, for storing the chemical agent, made of the material having enough corrosion resistance to each chemical agent.



Don't mix sodium hypochlorite with heavy metals or acids. In particular, toxic chlorine gas is generated when mixing sodium hypochlorite and acids.



Don't mix sodium hypochlorite with oxalic acid or citric acid, or toxic chlorine gas is generated.



Please stop the scouring air during the chemical cleaning, or the membrane elements might be damaged.

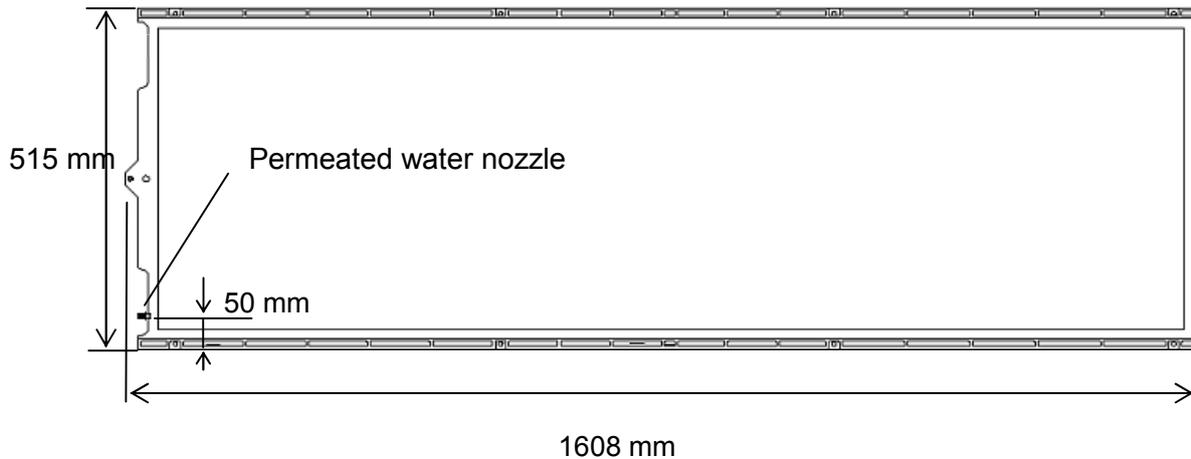
### III. SPECIFICATIONS AND PERFORMANCE OF “TMR140 SERIES”

#### 1. Specifications of Element

Table III-1 and Fig. III-1 shows the specifications and the appearance of the element for TMR140 Series, respectively.

**Table III-1 Specifications of Element (TSP-50150)**

Model name		TSP-50150
Membrane configuration		Flat sheet
Application		Filtration of activated sludge
Filtration method		Suction filtration
Nominal pore diameter (μm)		0.08
Effective membrane area (m <sup>2</sup> )		1.4
Dimensions (mm)	Total width	515
	Total height	1,608
	Thickness	13.5
Weight (kg)	Dry	4.8
	Wet (Reference)	8.0
Main material	Membrane	PVDF and PET non-woven fiber
	Supporting panel	ABS resin



**Fig. III-1 Appearance of Element**

#### 2. Specifications of Polyurethane Permeate Tube

Table III-2 shows the specifications of Tube.

**Table III-2 Specifications of Polyurethane Permeate Tube**

Material	Thermoplastic polyether-polyurethane TPU-ARET* <sup>1</sup>
Inside diameter / outside diameter / total length (mm)	8/11/380

\*Allowable temperature limit: 60 degree C

\*1 The material name due to the ISO-18064.

### 3. Specifications and Performance of “TMR140 Series” Module

Table III-3 shows the specifications of “TMR140 Series” modules.

**Table III-3 Specifications of Module**

Model name		TMR140-050S	TMR140-100S	TMR140-200W	TMR140-200D	TMR140-400DW
Number of membrane elements		50	100	200	200	400
Element block (EBL) structure		1 EBL	1 EBL	2 EBLs jointed	Double Deck with 2 EBLs	4 EBLs (2x2)
Dimensions <sup>*1</sup>	Width (mm)	810	810	840	810	840
	Length (mm)	950	1,620	3,260	1,620	3,260
	Height (mm)	2,100	2,100	2,100	4,160	4,160
Weight (kg)	Module (dry)	400	695	1,430	1,365	2,710
	Aeration block (dry)	40	65	150	65	150
	Element block (dry)	360	630	1,280	1,300	2,560
	Element block (sludge clogging) <sup>*2</sup>	690	1,240	2,480	2,500	4,980
Material	Frame	304 stainless steel (316LSS is available as option)				
	Diffuser, Permeated water manifold	304 stainless steel (316LSS or Polypropylene <sup>*7</sup> is available as option)				
	Element fixing gaskets	EPDM rubber				
Connection flange <sup>*3</sup>	Manifold	ANSI 1 1/2 inch	ANSI 2 inch	ANSI 3 inch	ANSI 2 inch	ANSI 3 inch
	Air diffuser	ANSI 1 1/4 inch	ANSI 1 1/2 inch	ANSI 2 inch	ANSI 1 1/2 inch	ANSI 2 inch
Operating range	Temperature	5-40 degree C				
	pH <sup>*4</sup> of liquid	5-10				
	MLSS	Not higher than 18,000 mg/L				
	Trans-membrane pressure	Not higher than 20 kPa (200 mbar)				
	Cleaning chemicals feed pressure	Not higher than 10 kPa (100 mbar)				
	Cleaning chemicals and chemicals concentration	Sodium hypochlorite (effective chlorine concentration) : 2,000-6,000 mg/L (pH is around 12) Oxalic acid : 0.5-1.0wt% Citric acid : 1.0-3.0wt%				
	Scouring Air Flow rate <sup>*5</sup> (NL/min/Module) <sup>*6</sup>	500 - 1,000	1,000 - 2,000	2,000 - 4,000	1,300 - 2,000	2,600 - 4,000

\*1 The total dimensions excluding the connection tube

\*2 The weight assumed in the case of sludge clogging between elements.

\*3 The flange dimensions are described in the drawings attached to this manual. UNI (ISO) flange is also available as option.

\*4 Except when the chemical cleaning with the designated chemical agents..

\*5 The air supply equipment such as blower shall be designed based on the standard operating conditions shown in Table VII-1.

\*6 “NL” means air volume as being 0 degree C and 101.325 kPa (1 atm).

\*7 Please contact Toray if you would like to use Polypropylene diffuser/permeated water manifold. Additional information will be provided.

Table III-4 and III-5 shows the performance of "TMR140 Series" modules.

**Table III-4 Permeate water quality**

Model name		TMR140-050S	TMR140-100S	TMR140-200W	TMR140-200D	TMR140-400DW
Permeate water quality <sup>*1</sup>	TSS (mg/L) <sup>*2</sup>	Not higher than 3.0				
	Turbidity (NTU) <sup>*3</sup>	Not higher than 1.0				

\*1 This value can be attained when operated under the standard operating conditions as specified in this Instruction Manual during a period specified separately by Toray.

\*2 Measuring method of TSS is complied with Standard Method of Examination of Water and Wastewater 20<sup>th</sup> Edition (1998), Section 2540D, Total Suspended Solids Dried at 103-105 degree C or ISO 11923.

\*3 Measuring method of NTU is complied with Standard Method of Examination of Water and Wastewater 20<sup>th</sup> Edition (1998), Section 2130, Turbidity or ISO 7027.

**Table III-5 Flow capacity (Reference value)**

Model name		TMR140-050S	TMR140-100S	TMR140-200W	TMR140-200D	TMR140-400DW
Continuous Filtration Flow (m <sup>3</sup> /d)	Sewage	8 - 53	15 - 105	30 - 210	30 - 210	60 - 420
	Industrial wastewater	8 - 35	15 - 70	30 - 140	30 - 140	60 - 280

\*4 This value is just a reference value and not a guarantee value of Toray. Sustainable operating filtration flow capacity varies among the plant depending on the type of wastewater, total process design and operating condition. In case of industrial wastewater application, it is strongly recommended to conduct a pilot test before membrane tank designing.

#### IV. MEMBRANE FILTRATION PROCESS DESIGN FOR “TMR140 SERIES”

The standard filtration pattern time chart, the schematic flow diagram of the membrane filtration, the layout of “TMR140 Series” modules in the membrane submerged tank, and the piping procedures are described in this section. These would help you design the membrane filtration process with “TMR140 Series”.

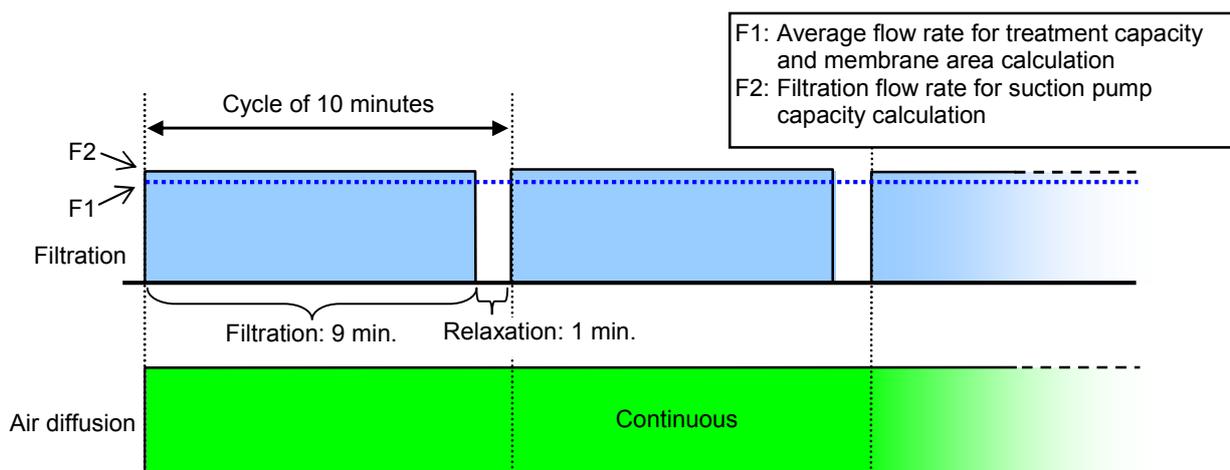
##### 1. Standard Time Chart

Two kinds of the filtration patterns are available with "TMR140 Series". Usually intermittent filtration (filtration with relaxation) is adopted and details are shown below, whereas sometimes simple continuous filtration can also be applied. In both cases aeration shall be done continuously while filtrating.

In the case of the intermittent filtration, the filtration is suspended (“relaxed”) for a short period at certain intervals while the air scouring continues, as shown in Fig.IV-1. While the filtration is suspended, the membrane surface is cleaned up more effectively with the scouring air due to the absence of suction. Although the automatic system control for periodical start and stop of the filtration is required, the intermittent filtration is recommended for stable and efficient membrane filtration. The recommended time cycle for the intermittent filtration is 9-minute filtration and 1-minute relaxation.

Please stop the scouring air when the filtration operation stops except for the following conditions:

- 1) Each relaxation period in case of applying intermittent filtration.
- 2) In case that the plant operation stops for a while, aeration is applicable for mixing or aeration demand, however, the flow rate should be controlled minimal.



**Fig.IV-1 Recommended Time Chart for Intermittent Filtration**

## 2. Flow Diagram of Membrane Filtration

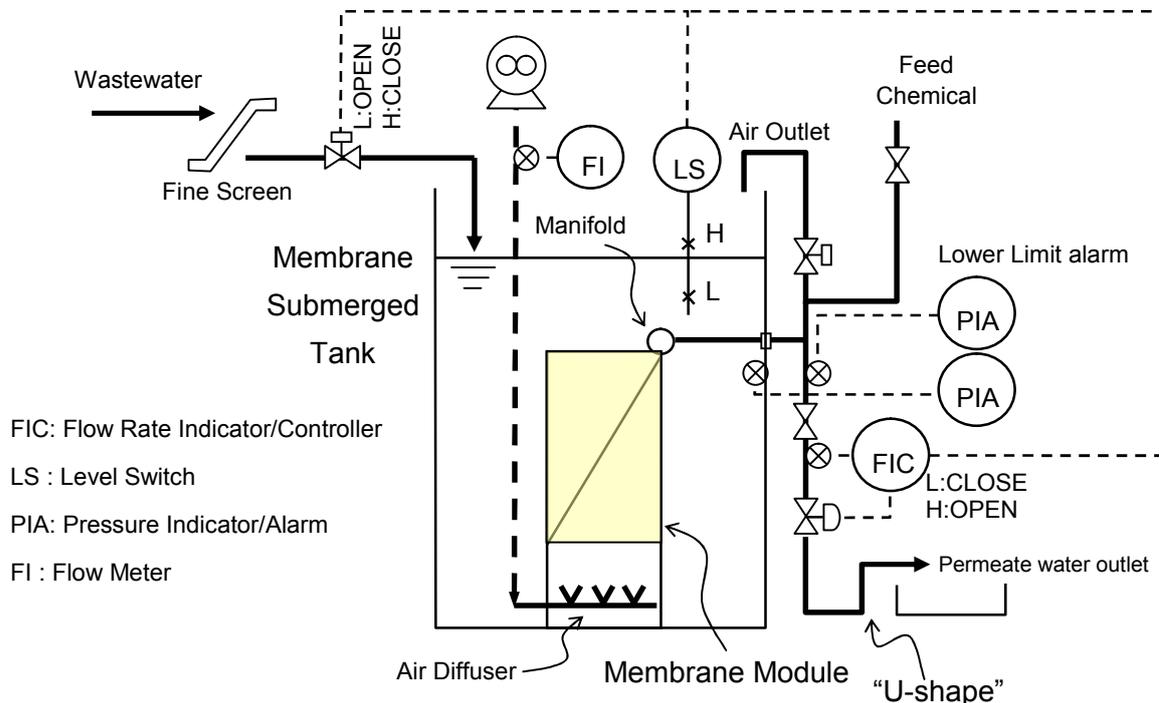
Two schematic flow diagrams of the membrane filtration process are shown below. One is for the gravity filtration with water head difference and the other is with suction pump. Major necessary peripheral devices for membrane filtration process are described in the latter part of this section.

In any case, the fine screen with openings of 3.0 mm or under should be installed before the membrane submerged tank, or the modules might be polluted and clogged severely with trashes brought with the raw water.

It is also recommended to prepare enough capacity of the buffer tank (flow equalization tank) prior to the MBR process to equalize BOD load and filtration flow capacity so as to enable stable operation of the biological treatment and membrane filtration process.

### (1) Gravity filtration configuration

The filtration can be performed with using a natural water head differential pressure generated from a vertical distance between the liquid level of the membrane submerged tank and the level of the permeate water outlet (see Fig. IV-2).



**Fig. IV-2 Schematic Flow Diagram for Gravity Filtration**

In order to obtain enough suction pressure for the filtration considering the friction loss of pipe and valves, the permeate water outlet should be located sufficiently below the liquid

level of the membrane submerged tank (normally 3 m below water level or lower).

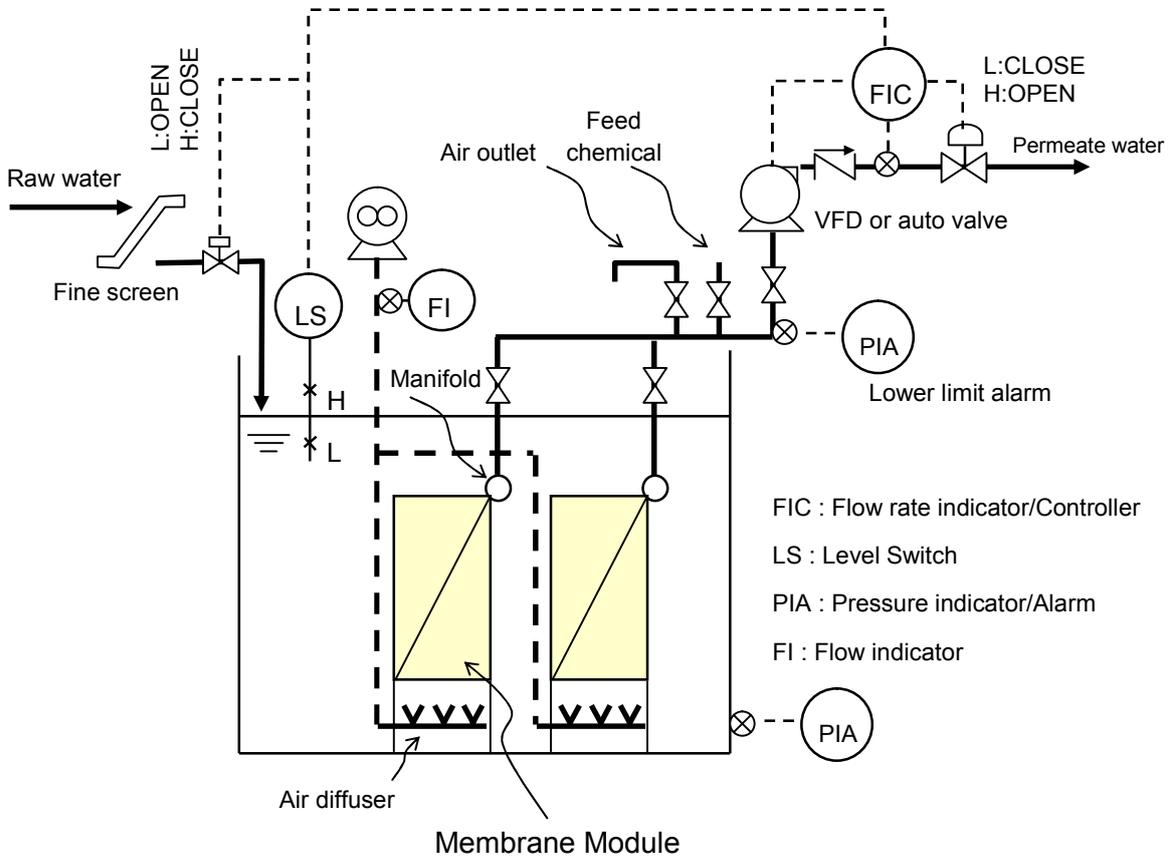
It is recommended that the piping from the permeate water manifold to the permeate water outlet should directly penetrate the tank wall, as shown in Fig.IV-2. Also if the permeate water outlet is located in the open air, it is recommended to make the outlet pipe U-shape to seal the piping with water.

The permeate water flow is controlled with the automatic control valve (the permeate control valve). When the liquid level of the membrane submerged tank gets to the lower limit, this control valve fully closes the permeate water line to stop the filtration. When the liquid level gets to the higher limit, the automatic shutter valve on the raw water feed line closes its line to stop raw water coming.

In this gravity filtration, the air accumulated in the permeate water line should be discharged once a day at least; otherwise the effective water head is reduced seriously. The air purge nozzle should be installed at the highest position of the permeate water line and the automatic shutter valve (the air purge valve) is recommended to be installed on the line just before the nozzle. (As shown in Fig.IV-2) Stopping the filtration (fully closing the permeate control valve) and opening the air purge valve for a few minutes, the air is easily purged.

(2) Pump suction configuration

Fig. IV-3 illustrates the general configuration for pump suction filtration.



**Fig.IV-3 Schematic Flow Diagram for Pump Suction Operation**

The permeate water flow is controlled by a flow meter and a suction pump with an automatic control valve or by a flow meter and a suction pump with VFD control. In case water level in the membrane submerged basin gets to the lower limit, filtration has to be stopped. If the water level reaches the upper limit, the level controller will stop raw water inflow.

In some cases with this pump suction configuration, an equipment may be needed to discharge the air accumulated in the permeate water line. A range of methods can be applied for this air removal such as vacuum pump, ejector or manual water injection. Please contact TORAY or refer to the engineering manual for the details.

(3) Necessary devices for membrane filtration process

Major necessary peripheral devices to operate membrane filtration process are explained below. Some other devices than mentioned below might be required case by case.

a. Fine screen

The wastewater should be treated by screen with openings of 3.0 mm or under before flowing into the membrane submerged tank, otherwise the modules are polluted and clogged with foreign substances seriously. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

b. Flow control device

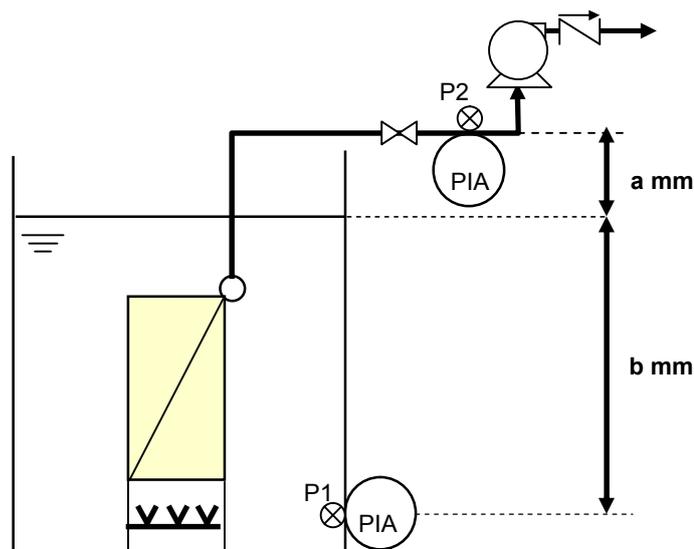
A flow rate controller, a flow meter combined with an automatic control valve, or a flow meter combined with VFD controlled suction pump should be installed on the permeate water line to control the flow rate of permeate water. In the case of operating a number of “TMR140 Series” modules simultaneously in one train, it is advised to install one flow rate controller for one train of the modules.

c. Differential pressure measurement & calculation

For trans-membrane pressure (TMP) determination the differential pressure (in the permeate line and water level) has to be measured and calculated, either by installing two pressure sensors and calculating the readings in the PLC or by using a differential pressure device.

In the former case, one pressure gauge should be installed on the permeate water line and the other one in the membrane submerged tank, to monitor the trans-membrane pressure. In case of operating a number of “TMR140 Series” modules simultaneously in one train, it is advised to install one differential pressure measuring instrument for one train of the modules.

[Example]



**Fig.IV-4 Differential Pressure Measurement & Calculation**

- a = 1,000 mm (= 10 kPa, 100 mbar), b = 3,000 mm (= 30 kPa, 300 mbar)
- PIA readings;

	Filtration (pump ON)	Relaxation (pump OFF)
P1 (kPa)	29	30
P2 (kPa)	-15	-10

In this case, differential pressure (dP) is calculated as follows;

$$dP = (P1_{\text{Filtration}} - P1_{\text{Relaxation}}) - (P2_{\text{Filtration}} - P2_{\text{Relaxation}}) = (29) - (30) - [(-15) - (-10)] = 4 \text{ kPa}$$

d. Air supply unit (such as a blower)

This unit supplies air to the air diffusers of "TMR140 Series" module. The air flow rate supplied to the module should be always within the range of "Scouring Air Flow Rate" indicated in Table III-3.

e. Air flow meter.

An air flow meter is recommended to be installed to check the flow rate of the scouring air supplied to the module. In case of operating a number of "TMR140 Series" modules simultaneously in a train, it is advised to install at least one air flow meter for each train.

f. Suction pump

A suction pump is required in the case of pump suction configuration. Accurate flow rate control is needed for the suction pump with VFD control. The use of a volute pump (centrifugal pump) or volumetric pump (screw pump) with self-priming function is recommended.

g. Level sensor

Level sensor is necessary to be installed in the membrane submerged tank to monitor and control the liquid level of the membrane tank and to calculate the TMP in PLC.

h. Siphon breaking piping

In case of pump suction, filtration flow may not be stopped by stopping suction pump if the discharge point of the permeate water is lower than water level of the membrane submerged basin. This siphon flow has to be avoided and permeate flow has to be stopped whenever pump stops.



**CAUTION**

Please install the screen with openings of 3.0 mm or under before the membrane submerged tank. It is recommended to use the mesh type screen. Overflow or waste carryover must be avoided at any time.

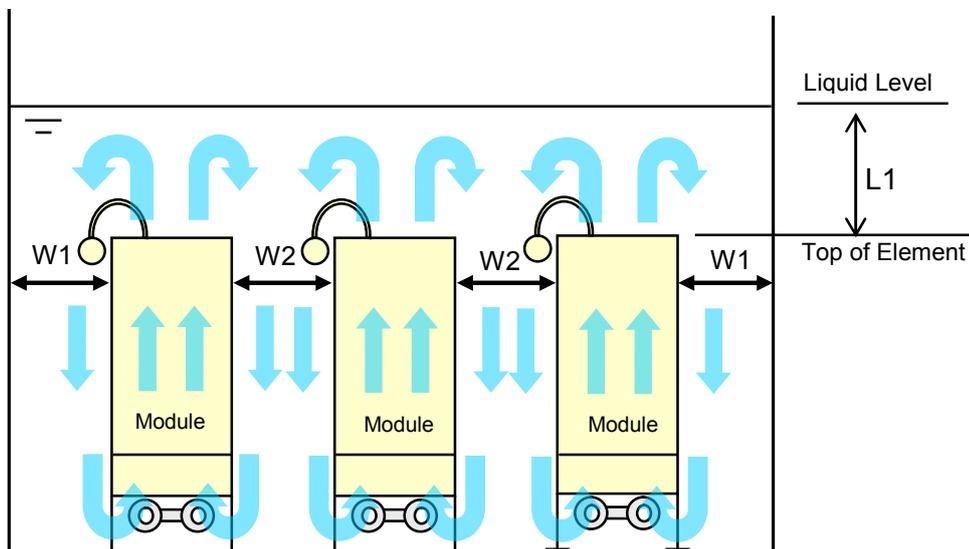
### 3. Layout of “TMR140 Series” Modules in Membrane Submerged Tank

#### (1) Layout of Modules in Membrane Submerged Tank

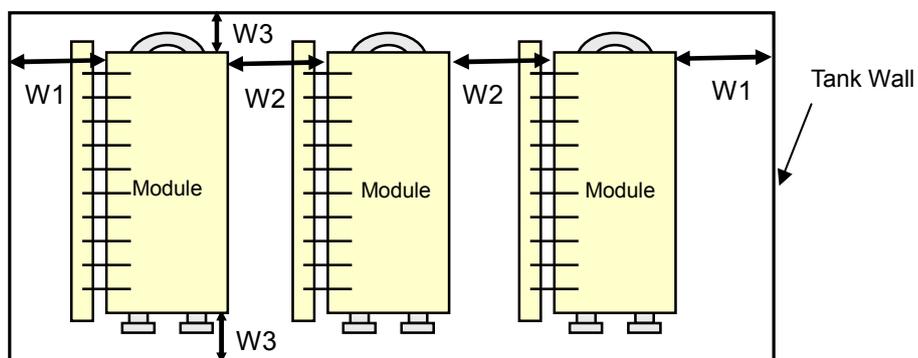
Fig.IV-5a shows how the liquid circulates in the membrane submerged tank. An upward flow is generated as the air is supplied from the lower side of the membrane modules. The flow then goes downward along both sides of the element block.

This circulation flow cleans the membrane surfaces and at the same time agitates sludge liquid. It is very important to arrange the membrane modules with appropriate distances in order to obtain an effective circulation flow.

Fig.IV-5a and Fig.IV-5b present a side view and a top view of the tank containing three membrane modules respectively. It is required to keep the dimensions of W1, W2, W3 and L1 as mentioned below.



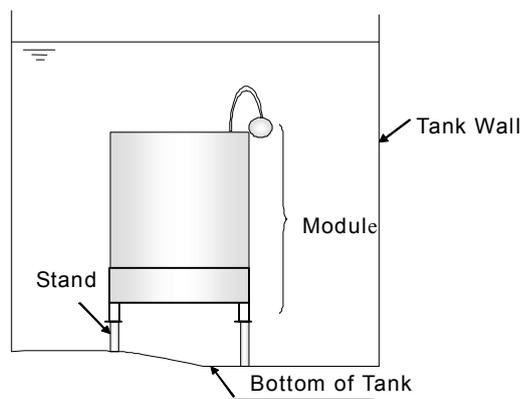
**Fig.IV-5a Membrane Module Layout in Membrane submerged Tank (side view)**



**Fig.IV-5b Membrane Module Layout in Membrane submerged Tank (top view)**

- (i) W1 : 380 to 680 mm
- (ii) W2 : 430 to 730 mm
- (iii) W3 : W3 should be as short as possible (normally about 400 mm) within the range allowing piping and maintenance work.
- (iv) L1 : L1, the distance between the top of the element and the liquid level of the tank, should be 500 mm or over at any time of the operation.

- \* Please contact us in the case of facing difficulties with a layout design, including installation of the membrane modules in the existing aeration tank.
- \* Please contact us in the case of the undulated floor of the tank. It is recommended to install the modules with stands as shown in Fig.IV-6.

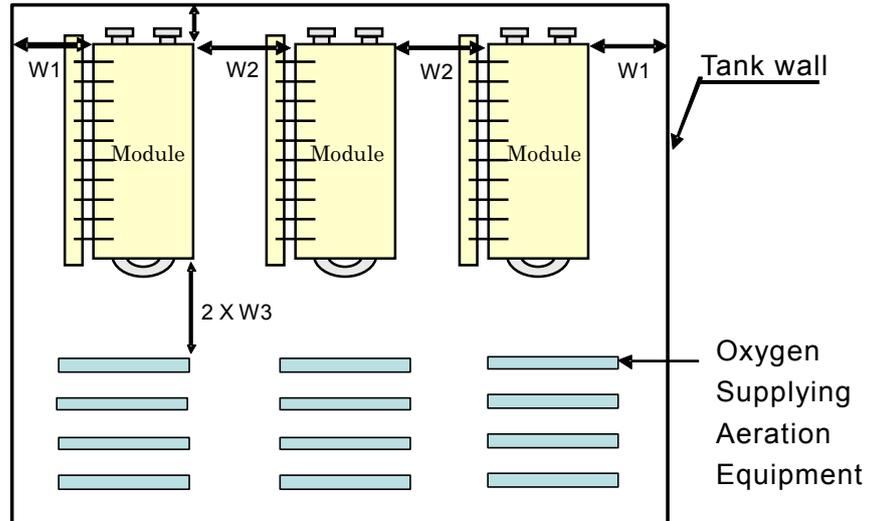


**Fig.IV-6 Installation with Stands (side view)**

## (2) Layout of Modules installed with Other Aeration Equipment

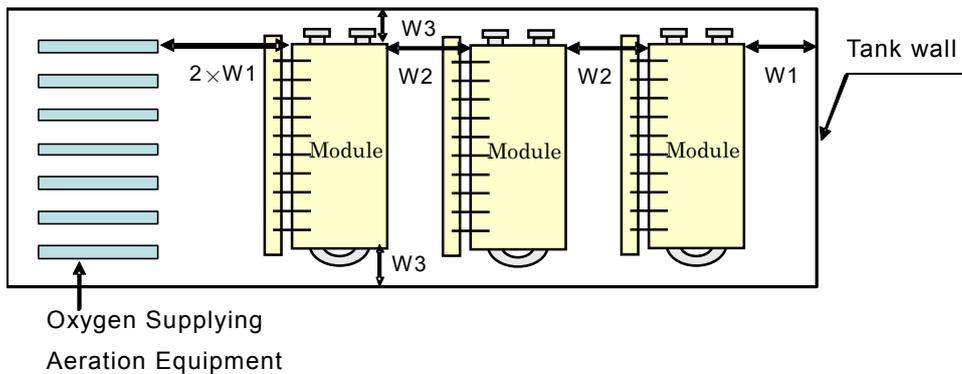
In the case that the membrane modules are installed in the tank with other oxygen-supplying aeration equipment or in the existing tank where there is already other oxygen-supplying aeration equipment, please take the following precautions in addition to what is mentioned in the above section.

Please keep twice of W3 of the distance between the modules and other oxygen-supplying equipment in the case shown in Fig.IV-7,



**Fig.IV-7 Membrane Module Layout in Membrane Submerged Tank with Other Aeration Equipment (top view)**

Please keep twice of  $W1$  of the distance between the modules and other aeration equipment in the case shown in Fig.IV-8,



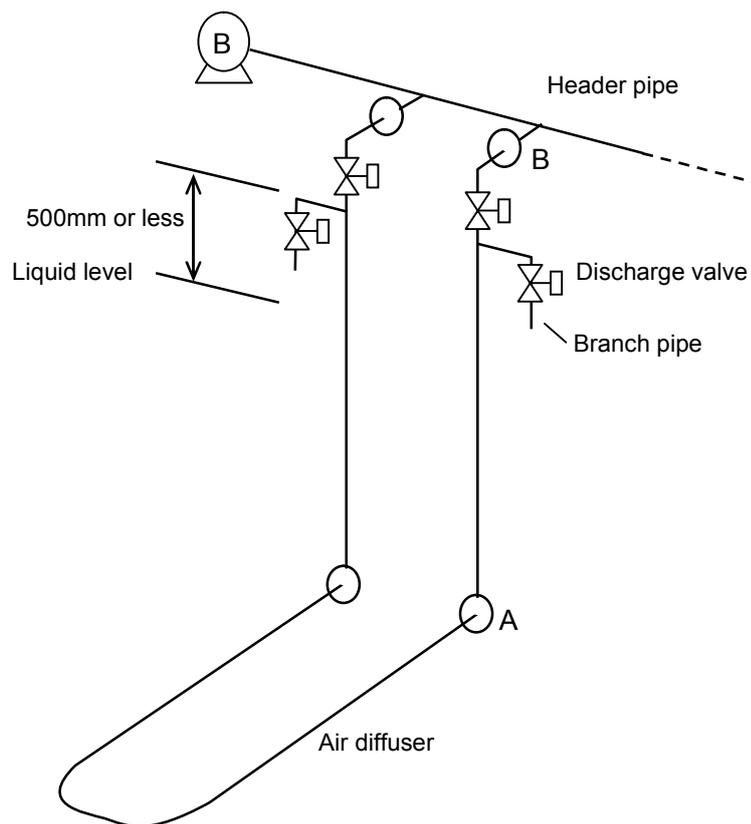
**Fig.IV-8 Membrane Module Layout in Membrane Submerged Tank with Other Aeration Equipment (top view)**

#### 4. Piping

The procedures of the pipe arrangement for the air diffusers and the permeate water manifold are described in this section. The connections of the air diffuser and the permeate water manifold are shown in the module drawings attached to this manual.

##### (1) Pipe Arrangement for the air diffusers

The pipe from the air supply device (the blower) is connected to the air diffusers with the flange (A). (see Fig.IV-9). It is recommended to install the flange connection (B) above the liquid surface on this pipe line in order to disjoint the piping in the case of lifting the modules.. Please install branch pipe and valves for cleaning the air diffuser with air jet from the blower. It is advisable to locate the branch pipe within 500 mm above the liquid surface, and it is highly recommended to install the automatic cleaning system with automatic valves. Please see VIII-2 for the procedure of cleaning the air diffusers.



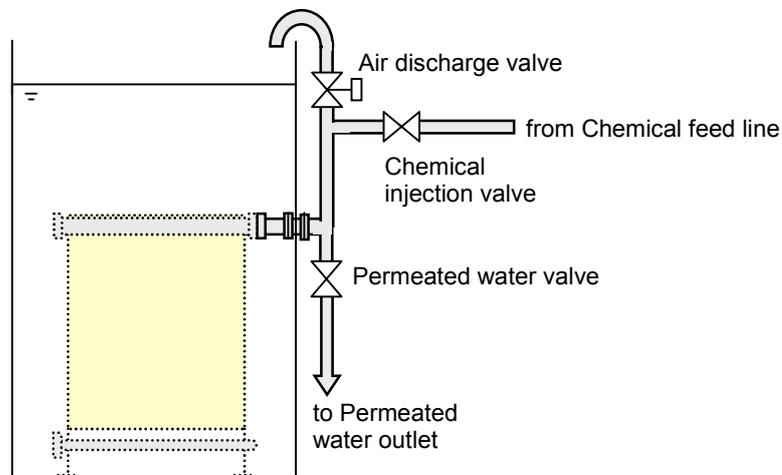
**Fig.IV-9 Example of Piping to Air diffuser**

(2) Piping to the manifold

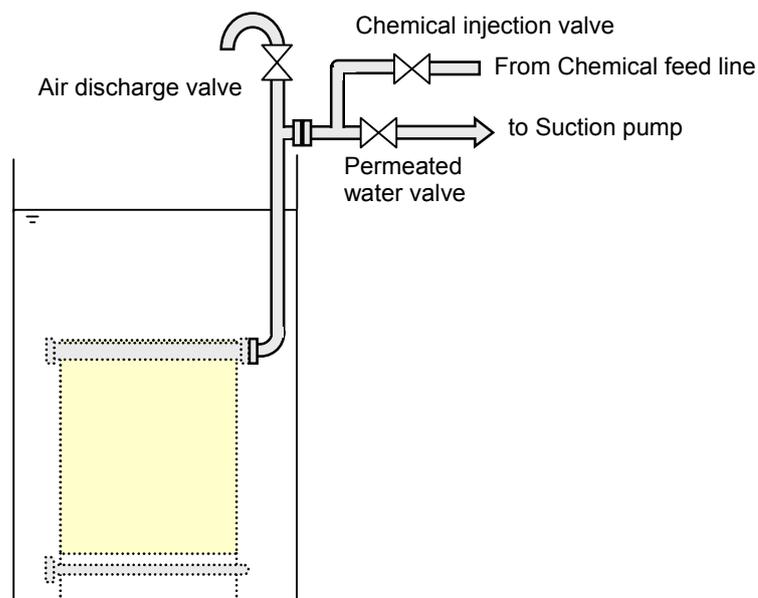
Fig.IV-10 and Fig.IV-11 give two examples of leading permeated water from the Membrane Submerged Tank. Fig.IV-10 shows downward piping and Fig.IV-11 shows upward piping.

The downward piping is for the operation with natural water head. The upward piping is for the operation with suction pump in the case that the pump is located above the Membrane Submerged Tank.

In both upward and downward piping, the chemical injection valve and the air discharge valve should be installed on a branch pipe of the line from the permeate water manifold to the permeate water valve. The devices necessary for chemical cleaning are described in VIII-3 to VIII-6.



**Fig.IV-10 Downward Piping from Membrane Submerged Tank**



**Fig.IV-11 Upward Piping from Membrane Submerged Tank**

## V. INSTALLATION OF “TMR140 SERIES”

### 1. Preparatory Procedure

- (1) Make sure the transportation plan for “TMR140 Series” including a carry-in route.
- (2) Arrange all necessary equipments for unloading “TMR140 Series” from the truck, such as forklift.
- (3) Prior to installation, please confirm that all necessary works in the membrane submerged tank are completed. All waste from the tank, such as concrete clusters, scrapes and mill ends, should be removed completely. Also, please confirm that there is no leakage of water or air from the tanks or pipes.

### 2. Unloading/lifting Products

Unload "TMR140 Series" with suitable equipment such as forklift.

Please note the followings for unloading "TMR140 Series".

- (1) The element block and the aeration block are separately packed in cardboard box and delivered. The element block contains a fixed number of membrane elements installed in it.
- (2) Do not hoist the delivered cardboard box which contains element block(s) or aeration block(s). Please use forklift for moving the box on site.
- (3) Do not stand or sit on the top of the box.
- (4) When lifting "TMR140 Series" (or lifting element block / aeration block separately) after unpacking, please set a hook on all hang holes and lift it keeping it horizontal.
- (5) Please be careful not to damage element nozzles, air diffusers, permeate manifolds or other components.
- (6) Please ensure safety anytime when doing these operations.



When lifting “TMR140 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR140 Series” from shaking. Never allow any person under “TMR140 Series”.



Please use chains or slings compatible with lifting weight.



Be sure to set down the module where there is no obstacle. Otherwise, the module may topple down and get damaged.

### 3. Checking Products

Please check the followings soon after carrying in "TMR140 Series":

- (1) All items are delivered as stated in the shipping ticket.
- (2) No damage is caused in transit.
- (3) The protective covers are fit in the right position.

### 4. Storage Products

Please store "TMR140 Series" indoors under lower than 40 degree C of the temperature, keep it horizontal and avoid direct sunlight to prevent the membrane from deterioration.

Throughout the entire process of installation work from transportation to operation startup, please take adequate measures to protect the elements and other components from damage. Especially please protect them from sparks caused in welding, fusion cutting or grinding, by using fireproof sheets or other protective measures.

If "TMR140 Series" is to be stored outdoors unavoidably during construction period, please minimize the period of outdoor storage, and also comply with the following requirements:

- (1) Maintain the temperature below 40 degree C.
- (2) Prevent from freezing.
- (3) Prevent from getting wet and dew condensation.
- (4) Prevent from immersed in the water.
- (5) Avoid direct sunlight.



Please do not leave "TMR140 Series" for hours in the place where the temperature is higher than 40 degree C or in the place exposed to direct sunlight. Especially ABS supporting panel may be deteriorated with direct sunlight, ultraviolet ray.



Protect "TMR140 Series" from freezing.



Take adequate measures to protect "TMR140 Series" from sparks caused in welding, fusion cutting or grinding.



Protect the element from damages. Don't put any heavy objects on the module. Protect it from collision with other object.



Be careful not to damage the rubber parts of air diffusers and element fixing brackets.

## 5. Installation Products

Please check the followings before module installation:

- (1) All the necessary works in the membrane submerged tank has been completed.
- (2) Tank and pipes have been cleaned.
- (3) Please confirm that there is no leakage of water or air from the tanks or pipes.
- (4) Operation checks of major equipments, including pumps, blowers, sensors and control system, have been confirmed by clean water test.

Please check the tie-in with the assembly drawings attached at the end of this manual. And please contact TORAY beforehand if you want to install the module in the tank without using anchors (e.g., using guide rails instead).

- (1) Installation Aeration Blocks (on the bottom of the membrane submerged tank using anchors)

Please first install the aeration blocks in the membrane submerged tank using anchors.

The air diffusers should be set horizontal in order to achieve uniform scouring aeration. The maximum allowable levelness error for the air diffusers is 3/1,000 on the top surface of the aeration block in both lateral and longitudinal directions.

- (2) Plumbing in Air Diffusers

Prior to plumbing in the air diffusers, please flush all pipes out. The air diffuser should be connected to the pipe from air supply unit with the flanges.

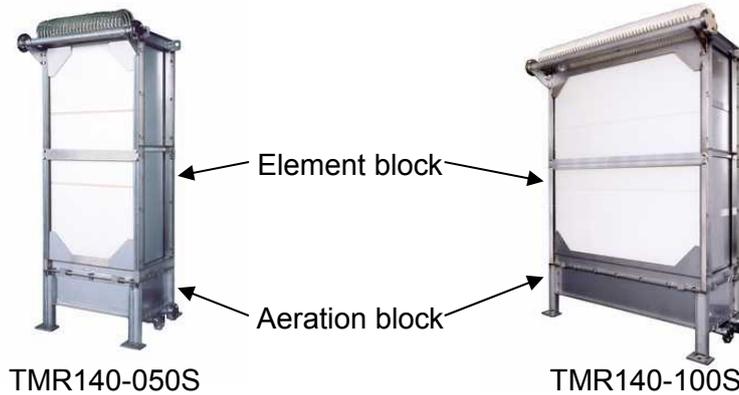
After plumbing in the air diffusers, please charge the membrane submerged tank with clean water until the aeration blocks are completely submerged in the water, and then supply air to the air diffusers. Please check the air shall be provided evenly for each aeration block and also the air shall be diffused evenly in each aeration block.

- (3) Installation Element Blocks

Please take the following steps for each module type and install the element blocks on the aeration blocks. Please be sure to take adequate measures after installation, to protect the elements and other components from damage, such as covering with fireproof sheets.

- a. TMR140-050S and 100S

Please put the element blocks on the aeration blocks and joint both of them using provided bolts.



b. TMR140-200W

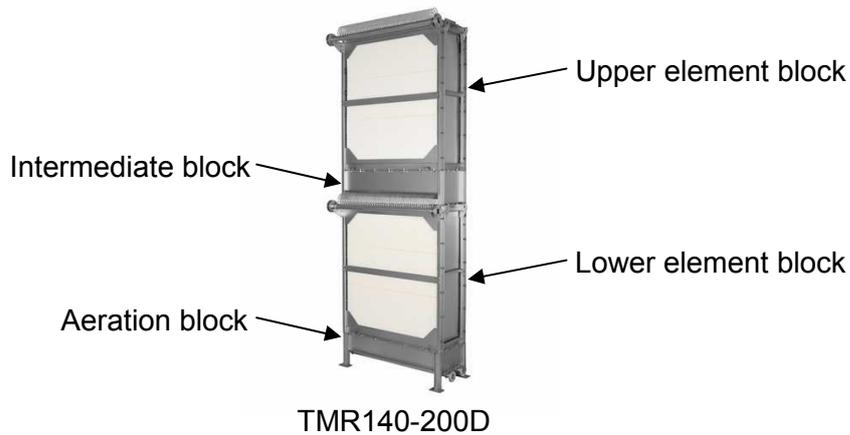
Model "TMR140-200W" consists of two element blocks and one aeration block. Each element block has one manifold and each manifold has one blank flange at the end. Please remove beforehand a blank flange from both element blocks which would be an obstacle when jointing those two element blocks.

Then, put those two element blocks on the aeration block and joint those element blocks with the aeration block using provided bolts.



c. TMR140-200D

At first, please put the lower element block furnished with intermediate block onto the aeration block, and joint it with the aeration block using provided bolts. And next, please put the other (upper) element block on the first element block, and joint it with the intermediate block using provided bolts.



d. TMR140-400DW

Model "TMR140-400DW" consists of four element blocks (two upper, two lower) and one aeration block. Each element block has one manifold and each manifold has one blank flange at the end.

At first, please locate two (upper/lower) element blocks on the level. Then remove beforehand a blank flange from all element blocks, loosen the U-bolts on the manifolds, connect one manifold to the other one manifold, fasten U-bolts and check that the manifolds are secured firmly. After that attach the connection plates\* to the middle of upper/lower two blocks, and attach the intermediate blocks onto the lower two blocks by provided bolts.

And then, please put the lower element blocks furnished with intermediate blocks onto the aeration block using I-beam hanger\*, and next, please put the other (upper) element blocks on the intermediate blocks using I-beam hanger\*.

*\* Reference drawings of connection plates and hanger are supplied by Toray, however these are just for your reference. Design, manufacturing and usage of these parts shall be done with OEM's responsibility considering local safety regulation.*



#### (4) Plumbing in Permeate Water Manifold

Please take the following steps for each module type.

The manifold is shipped from the factory with one blank flange furnished at one end. Please connect the manifold to the permeate water line at the other end. It is requested for the buyer to get and use the flange fit for the connection of the manifold if necessary.

As the manifold is designed to allow fine adjustment of height with the brackets on its both ends, please adjust the brackets to raise the permeated water outlet side a little higher than the other side in order to prevent the air from accumulating in the manifold.

Please flush out the permeate water line before connection. Don't apply pressure to the permeate side of the element, or the element may get damaged.

Please take the following steps for each module type.

a. TMR140-050S and 100S

Please connect one end of the manifold to the permeated water pipe, and leave the other end closed with a blank flange.

b. TMR140-200W and 400DW

(i) One-side connection

Please loosen the U-bolts on the manifolds, connect one manifold to the other, fasten U-bolts and check that the manifolds are secured firmly. And then, connect one end of the joined manifolds to the permeated water pipe. The other end of the manifold should be left closed with a blank flange.

(ii) Two-side connection (alternative)

Please loosen the U-bolts on the manifolds connect one manifold to the other, fasten U-bolts and check that the manifolds are secured firmly. And then, please connect both ends of the joined manifolds to the permeated water pipe.

c. TMR140-200D and 400DW

Please connect one end of each upper and lower manifold to each upper and lower permeated water line. Please leave the other end closed with a blank flange.



When lifting "TMR140 Series", please attach chains or slings to it and lift it straight upward calmly to prevent "TMR140 Series" from shaking. Never allow any person under "TMR140 Series".



**DANGER**

Use chains or slings compatible with lifting weight.



**DANGER**

Never climb the module. Please set up the foothold when installation. Use protective equipments to ensure the safety.



**CAUTION**

Don't apply pressure to the permeate side.

## VI. START OF OPERATION

### 1. Clean Water Operation

#### (1) Checking items before operation

At first, please make the following inspections and arrangements in this order:

- a. Check that the air diffusion pipe and the permeated water pipes are connected properly.
- b. Check that the element block is securely installed on the aeration block.
- c. Check that the membrane submerged tank has been cleaned up completely and then remove the protective cover. The presence of soil and dust may cause damages to the module.
- d. Open the air discharge valve to release air from the element before feeding clean water to the membrane submerged tank.
- e. Feed clean water (tap water or filtered water) to the membrane submerged tank up to the operating liquid level.
- f. Close the air discharge valve after feeding water.



Open the air discharge valve before feeding clean water to the membrane submerged tank. Close the air discharge valve after feeding water.



Don't use natural ground water for clean water operation, as it may contain much amount of iron, manganese, calcium, and silica which may cause the clogging in the membrane.

#### (2) Clean water operation

After feeding clean water to the membrane submerged tank, please start clean water operation in accordance with the following procedure:

- a. Start the blower to supply air to the air diffusers. Check that the required amount of air is supplied to the air diffusers and the air is diffused evenly within each module.
  - \* Foaming may occur in the membrane submerged tank during clean water operation. This phenomenon is caused by the dissolution of biodegradable hydrophilic components contained in the membrane. Operation can be continued regardless of the foaming.
- b. When using only one blower to achieve air diffusion for two or more modules, check that the required amount of air is evenly supplied to each module. Otherwise, modify the piping structure (such as the diameter of the header pipe) to attain uniform air supply.

- c. Check the control devices work well during the clean water operation,
- d. Start filtration with clean water. Measure and record the trans-membrane pressure and water temperature at designed filtration rates (at a normal, maximum and minimum flow rate). Maintain such records.
- e. Stop the filtration and the air supply as soon as the above tests finish.



**CAUTION**

Don't conduct clean water operation for a long time. Clean water operation tends to cause membrane clogging.



**CAUTION**

Keep the membrane wet once it gets wet with clean water operation. If that membrane get dried up, the permeability may be decreased seriously.

## 2. Seeding Sludge Injection

The membrane may get clogged seriously if you filtrate the wastewater without activated sludge, so don't fail to inject the seeding sludge first before starting filtration.

Please inject the seeding sludge to the membrane submerged tank with the following steps:

- (1) Transport fresh and healthy activated sludge from the other wastewater treatment plant treating the same kind of wastewater. Activated sludge with higher MLSS concentration and higher MLVSS/MLSS ratio is preferable. Initial MLSS concentration of the membrane submerged tank shall be preferably 7,000 mg/L or higher, at least 3,000 mg/L.
- (2) Supply the seed sludge through the screen to the tank.
- (3) Please start feeding the raw wastewater soon after the sludge injection.
- (4) Do not use seeding agents.
- (5) Do not use silica-based anti-foam agent in case of foaming.



**CAUTION**

Remove foreign matters from the seeding sludge with the mesh screen whose opening is 3.0 mm or under before injection.

## 3. Actual Filtration Operation

Following the seeding sludge injection, please start the air diffusion, the filtration and the raw wastewater feed.

Attention needs to be paid to this start-up operation such as:

- (1) Start filtration with much lower flux than design value, especially when seeding sludge MLSS does not reach 7,000 mg/L, and gradually increase the flux

considering F/M ratio. Initial seeding sludge is not yet acclimatized to the MBR operation and in such condition filtration with higher flux may lead to membrane fouling.

- (2) Sludge parameters such as MLSS and sludge filterability should be checked frequently to assess the actual sludge condition.
- (3) Check the air diffuser cleaning procedure and confirm it works. Details for the procedure are given in the chapter VIII
- (4) Once the permeate water flow gets stabilized, please measure and record the trans-membrane pressure and the liquid temperature. Details for operation control are given in the next chapter.

## VII. OPERATION CONTROL

### 1. Standard Operating Conditions

Table VII-1 shows standard operating conditions for "TMR140 Series".

These operating parameters such as MLSS, sludge viscosity, DO (dissolved oxygen concentration) and pH should be kept in the range of the standard operation conditions given in Table VII-1 in order to ensure stable operation.

The raw water should be treated with the proper pretreatment facilities before the membrane modules to remove foreign matters which is harmful to the membrane such as big chunks of suspended solid or oil.

Please use an alcohol-based antifoaming agent\* if necessary.

\* Recommended: *Kurita Water Industries "Kuriless P.F-663"*  
*Schill & Seilacher "Structol SB2032"*

The operating conditions may change from this standard conditions, depending on the characteristics of the sludge, the raw water quality and/or other given operating circumstances.

**Table VII-1 Standard Operating Conditions for "TMR140 Series"**

Parameter	Unit	Operating condition	
MLSS	mg/L	7,000 - 18,000	
Sludge viscosity*	mPa·s	Not higher than 100 ** Not higher than 250 ***	
DO	mg/L	1.0 or more	
pH	-	6 - 8	
Liquid temperature	degree C	15 - 40	
Continuous average filtration flux	m <sup>3</sup> /m <sup>2</sup> /d (m/d)	0.75 or less	
	L/m <sup>2</sup> /h (LMH)	31.2 or less	
Scouring air flow rate	TMR140-050S	NL/min/Module	650
	TMR140-100S		1,300
	TMR140-200W		2,600
	TMR140-200D		1,500
	TMR140-400DW		3,000

\* Measured by single cylinder rotary viscometer.

\*\* B type viscometer, e.g. VT-03F by Rion Co., Ltd.

\*\*\* C type viscometer, e.g. TVC-5 by Toki Sangyo Co., Ltd.



**WARNING**

Don't use the permeate water for drinking.



**WARNING**

Analyze the quality of the permeate water to ensure that the water quality meets the intended purpose before actual use.



**CAUTION**

Don't use chemicals, toxic agents, oils or other substances that can adversely affect activated sludge.



**CAUTION**

ABS supporting panel may get chemical cracks by some organic solvent, such as alcohols and oils, and some synthetic detergents. So don't make ABS panel contact such materials.



**CAUTION**

Avoid abrupt changes in pH, temperature, trans-membrane pressure or any other conditions even if they are within the standard operating conditions (Table VII-1).



**CAUTION**

Replace consumable parts regularly after inspection.



**CAUTION**

Protect the modules from freezing.

## 2. Operating Parameters

The performance of “TMR140 Series” varies in accordance with the raw water quality and the operating conditions. It is recommended to monitor and record the values of operating parameters in order to achieve the stable operation and the expected performance with “TMR140 Series”.

The following shows the operating parameters for the operation of “TMR140 Series”:

- (1) Scouring Air Flow rate (blower air flow)
- (2) Diffusion pressure (blower discharge pressure)
- (3) Permeated water flow rate
- (4) Trans-membrane pressure (TMP)
- (5) Liquid temperature of membrane submerged tank
- (6) DO (dissolved oxygen) concentration of membrane submerged tank
- (7) pH of membrane submerged tank
- (8) MLSS
- (9) Raw water quality (BOD, COD, turbidity, T-N, T-P, etc.)
- (10) Permeated water quality (BOD, COD, turbidity, T-N, T-P, TSS etc.)
- (11) Excess-sludge discharge rate
- (12) Sludge viscosity
- (13) Sludge volume (SV30 or SV60)
- (14) Sludge filterability

### 3. Basic Control Philosophy

Listed below is the basic control philosophy for operating “TMR140 Series”. Please note that this is a basic one and detailed control philosophy for each project shall be examined carefully on a case-by-case basis.

- (1) Suction pump: Run intermittently by timer (9 min on/1 min off), VFD control for flow rate, stop filtration by low MBR tank level or high TMP. It will never run when no air comes to MBR tank, and to ensure enough sludge mixing when restarting, pump is allowed to run after one minute delay from starting MBR air flow. It will stop during air diffuser cleaning.
- (2) Membrane scouring blower: 24/7 continuous operation except in the case of long operation stop by no feed or low membrane submerged tank water level (in that case, 5 min per hour intermittent aeration).
- (3) Membrane submerged tank water level: Low -> stop filtration for membrane protection, High -> stop wastewater feed.
- (4) TMP: High (+5kPa from initial) -> Alarm for chemical cleaning, High High (20kPa or above) -> Alarm, then stop filtration.
- (5) Air diffuser cleaning valves: Take action by timer at least once in a day (frequency shall be adjustable).

#### 4. Daily Inspection

For the operating parameters listed in the preceding section, perform inspection periodically, at least once per week, as follows. Please check trends of these data and take necessary actions before too late.

##### (1) Diffused air conditions

Please check that the fixed amount of air within the standard range is supplied from the diffuser by checking air flow-meter and pressure gage of the air supply line. Also, check that the air is diffused evenly within one module and also evenly among modules. Deviation in the scouring air flow rate from the standard intensity may cause the membrane clogging in the weak zone and element damage in the strong zone. So in such a case, stop filtration, and check the leakage from the piping, valve situation and the blower condition. If necessary, take appropriate actions, such as adjusting the scouring air flow rate. If extraordinary uneven diffusion still continues, conduct the air diffuser inspection and cleaning procedure described in Section 2, Chapter VIII.



If the scouring air flow rate drops or becomes extremely irregular or if air supply is stopped, then immediately stop filtration to prevent membrane clogging.

##### (2) Trans-membrane pressure

Please check that the trans-membrane pressure is stable and carry out chemical cleaning before the trans-membrane pressure increase by 5 kPa (50 mbar) from its initial operating level at the same permeated water flow rate. Sudden increase in the trans-membrane pressure suggests the membrane clogging caused by abnormal diffused air condition, too high flux, concentration of the sludge in membrane submerged tank or deteriorating sludge properties. In such an event, check the operating condition and biological condition and take necessary actions and carry out chemical cleaning of the elements.

##### (3) Activated sludge characteristics

The activated sludge of the membrane bioreactor should be self-cohesive and free from odor. The color of the activated sludge is typically brown, however differs among plants, depending on wastewater component, organic load and so on. If unexpected change is observed in sludge characteristics, check the operating condition, such as BOD load, MLSS concentration, DO, pH, temperature and/or wastewater component, and take appropriate actions.

(4) Water temperature

The desirable water temperature is 15 degree C to 40 degree C. If the temperature is out of this range and the activated sludge property is not good, it is recommendable to install temperature control device to cool or heat the liquid.

(5) DO

Any point in the aeration tank and the membrane submerged tank should be kept at oxic condition. If DO is less than 1.0 mg/L, take necessary actions such as increasing the air-flow rate of the biological aeration unit, or lower the sludge concentration by increasing excess sludge discharge rate. In case the blower and air piping for membrane scouring is not separated from the biological aeration system, control the membrane scouring air flow rate at fixed value without being affected by DO control in oxidation process.

(6) pH

The desirable pH range is 6 to 8. If pH is out of this range and the activated sludge property is not good, please adjust pH by gradually adding acid or alkali.

(7) MLSS

MLSS concentration in the membrane submerged tank should be normally 7,000 to 18,000 mg/L. If MLSS is too low, please decrease excess sludge discharge rate. If MLSS is too high, please check the return activated sludge flow rate and if it is low, please increase the RAS rate at proper value. If RAS rate is proper, please increase excess sludge discharge rate.

(8) Water level

Check the water level of the membrane submerged tank is kept in the appropriate range. If this requirement is not met, check the situation of the control system, particularly the condition of the level meter, pumps or membranes, and when necessary, take corrective actions.

(9) Sludge viscosity

It is desirable that the sludge viscosity is not higher than 100 mPa.s (measured by B-type viscometer) or 250 mPa.s (measured by C-type viscometer). If the sludge viscosity is too high, please check the operating condition and biological condition, such as F/M ratio, and take necessary actions.

(10) Sludge volume (SV30 or SV60)

This is almost same as what is usually measured in the CAS plant, the only difference is that MBR sludge needs to be diluted by permeate water (5-fold) to be measurable with usual method. This SV value can be an on-site indicator of sludge property and we recommend conducting this measurement routinely and checking the trend of the daily value in association with other inspection items. In case of abrupt decrease in SV value, check the operating condition and biological condition, and take necessary actions.

(11) Sludge filterability

Paper filtration method is simple and reliable method to grasp the filtration property of the sludge. Please see the method described in attached document. We recommend conducting paper filtration test and measurement of TOC and/or turbidity of filtered water routinely. In case of abrupt decrease in filterability and/or increase in TOC/turbidity, check the operating condition and biological condition, and take necessary actions.

(12) Pretreatment system

In addition to operating parameters for the operation of "TMR140 Series", please check the status of the pretreatment system (particularly the fine screen system) regularly and remove the accumulated trashes whenever necessary.

## VIII. MAINTENANCE OF “TMR140 SERIES”

### 1. Maintenance Items and Maintenance Frequency

Please perform strictly the following items to maintain “TMR140 Series” in good condition.

- (1) Clean the air diffusers (everyday)
- (2) Chemical cleaning of the element (when the trans-membrane pressure has risen by 5 kPa (50 mbar) or more from its initial operating level at the same permeated water flow rate or every 6 months, whichever comes first).
- (3) Replace connection tubes (once in 3 years, or when deteriorated)
- (4) Replace element fixing gaskets (once in 3 years or when deteriorated).
- (5) Replace elements (when the specified treatment flow rate is not gained even after chemical cleaning or when deteriorated, whichever comes first).



**CAUTION**

Be sure to use the specified types of the replacement parts.



**CAUTION**

Please contact TORAY for the detailed specifications and the procurement routes for replacement parts



**CAUTION**

Insert the tube securely into the foot of the nozzle when replacing the tube.



**CAUTION**

Don't apply excess force to the element and manifold nozzles to prevent damage when replacing permeate tubes or elements.,



**CAUTION**

Don't re-use the old permeate tubes once disconnected from the nozzles since the connection tightness of the tubes are reduced.



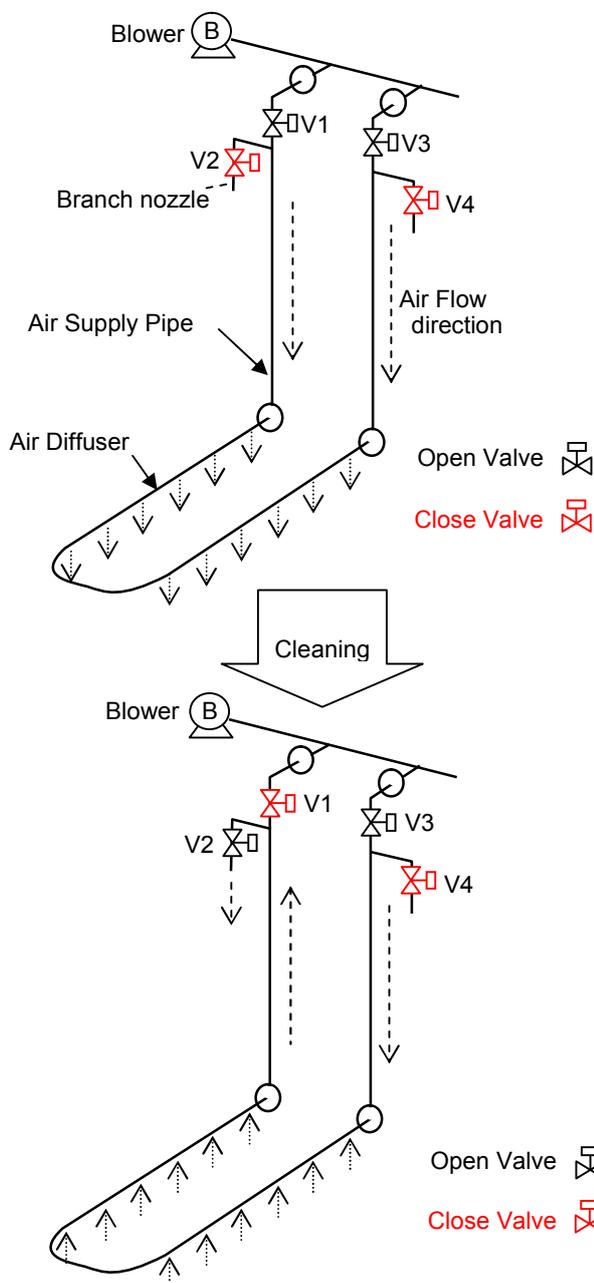
**CAUTION**

Please note that element replacement is admissible only under the presence of TORAY service staff.

## 2. Air Diffuser Cleaning

The clogging of diffuser holes causes uneven air diffusion and membrane clogging, and the elements are broken in the worst case. Please clean the air diffusers at least once a day or more to prevent such trouble (it is recommended to install the automatic air diffuser cleaning system with automatic valves). The air diffusers are cleaned up with the reverse flow of the sludge from the diffuser holes into the diffuser pipes, which is generated by the air jet flow from the blower through the air diffuser pipes to the branch discharge nozzle.

Please make sure of the discharge of sludge from branch nozzles when conducting diffuser cleaning. Frequent cleaning with longer discharge helps keep air diffuser clean.



### (1) Air diffuser cleaning procedure - Principle

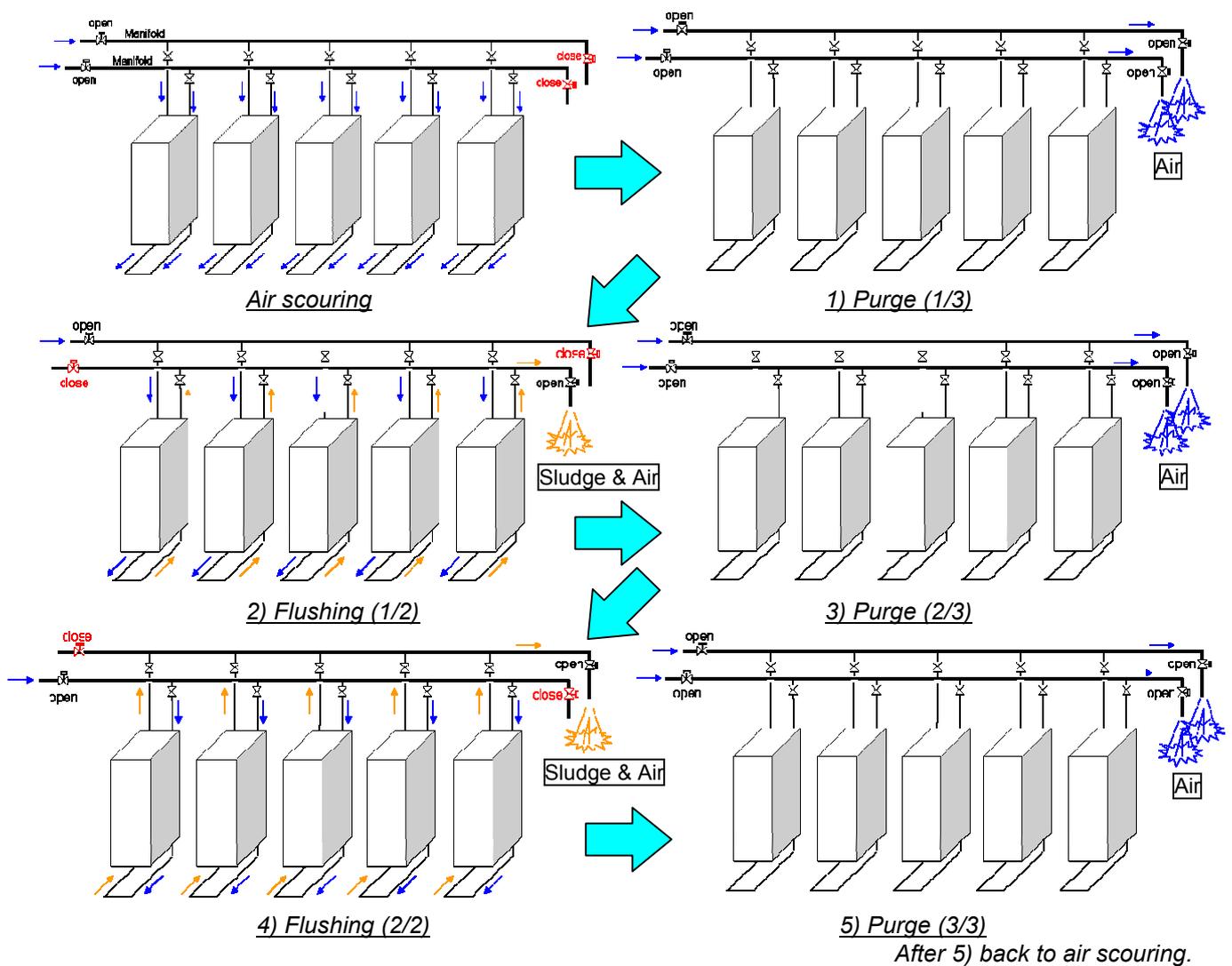
- (i) Stop filtration.
- (ii) Open V2 valve.
- (iii) Close V1 valve. At this step, the sludge liquid comes through the diffuser holes into diffuser piping, and is discharged together with the air.
- (iv) Keep V2 valve open for 1 to 5 minutes.
- (v) Open V1 valve, and then close V2 valve.
- (vi) Clean the other line in the same manner as follows.
- (vii) Open V4 valve.
- (viii) Close V3 valve. At this step, the sludge liquid comes through the diffuser holes into diffuser piping, and is discharged together with the air.
- (ix) Keep V4 valve open for 1 to 5 minutes.
- (x) Open V3 valve, and then close V4 valve.
- (xi) Restart filtration.

(2) Air diffuser cleaning procedure - Practical design

For multiple module operation, the flushing procedure described in the previous section can be applied for each module. However, a more convenient and simple approach is shown in Fig. VIII-1. Each inlet point of the air diffuser should be connected to each of two air headers, and each header equipped with two valves (automatic valves are strongly recommended) at the inlet point and end point (both higher than water level). The procedure & standard duration time of each action are as follows:

- Flushing: to clean air diffusers, 1 to 5 minutes for each flushing event.
- Purge: to blow out inside header pipes, around 30 seconds for each purge event.

Filtration must be stopped prior to starting the air diffuser cleaning procedure and restarted after air scouring is started. Please take care not to allow sludge to flow toward the blower.



**Fig.VIII-1 Air Diffuser Cleaning Procedure for Multiple Modules**

### 3. Chemical Cleaning of Element

Chemical cleaning of element should be conducted when the trans-membrane pressure rises to excess. Such a pressure increase can be caused when contaminants clog the pores of the membrane surface. The timing of chemical cleaning is determined as follows:

- (1) When the trans-membrane pressure rises by 5 kPa (50 mbar) from its initial operating level at the same permeated water flow rate or every 6 months, whichever comes first. For example, if an MBR was operated at 7 kPa (70 mbar) TMP in its initial period, then 12 kPa (120 mbar) is the TMP trigger for chemical cleaning.
- (2) If the trans-membrane pressure rises rapidly, please conduct chemical cleaning much earlier. The earlier chemical cleaning is much effective to recover and keep the permeability of the membrane.
- (3) In the case that the trans-membrane pressure rises by 5 kPa (50 mbar) within 6 months, it is recommended to observe how many months it takes for the trans-membrane pressure to rise by 5 kPa (50 mbar) and conduct chemical cleaning periodically. This measurement is effective to prolong the life of membranes.
- (4) When the permeability of the membrane is not recovered by a single chemical cleaning, there is a chance to recover permeability by carrying it out repeatedly.

### 4. Chemical Agents Available for Chemical Cleaning

It is quite important to select chemicals for the chemical cleaning in accordance with the type of adherent contaminant. Cleaning under inappropriate cleaning conditions or using the wrong chemicals may cause poorer filtration performance or damage the membrane. Please select chemicals suitable for each contaminant. Table VIII-1 shows suitable chemicals and standard cleaning conditions.

**Table VIII-1 Cleaning Chemicals and Standard Cleaning Conditions by Contaminant**

Contaminant	Chemical	Solution concentration	Amount used	Hold time
Organic matter	Sodium hypochlorite	2,000-6,000 mg/L (Effective chlorine concentration) (pH is about 12)	5 L/element	1 to 3 hours
Inorganic matter (either of the two chemicals)	Oxalic acid*	0.5-1.0 wt%	5 L/element	1 to 3 hours
	Citric acid	1-3 wt%	5 L/element	1 to 3 hours

\* Oxalic acid should not be applied when wastewater contains calcium, since calcium oxalate may form on the membrane surface which can choke membrane pores.

## 5. Handling of Chemical Agents

The chemical agents used for chemical cleaning are harmful to the health when in contact with the skin. When handling chemicals, wear protective goggles, protective gloves and other protectors. Make sure to check the details of its material safety data sheet (MSDS) and the instructions given below beforehand. If the chemicals should get into contact with your skin, follow the MSDS and take adequate actions for each chemical.

### (1) Sodium hypochlorite solution / NaClO

#### (A) Handling precautions

- (a) Ventilate well. Avoid heat sources and sparks. Also avoid contact with acids.
- (b) Handle the chemical container with great care. Avoid toppling, bumping or dragging it.
- (c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.
- (d) Firmly seal the container after use.
- (e) Thoroughly wash your hands and face and rinse out your mouth after using chemicals.
- (f) Don't eat or drink anything in the working place except in a designated place.
- (g) Don't bring gloves or other contaminated protectors into the rest area.
- (h) Forbid unauthorized entry to the place where chemicals are handled.
- (i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.
- (j) Provide local ventilation in the case of handling chemicals indoors.

#### (B) Storage precautions

- (a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.
- (b) Use corrosion-resistant containers for storage.

### (2) Oxalic acid / (COOH)<sub>2</sub>

#### (A) Handling precautions

- (a) Keep away from strong acids and bases.
- (b) Handle the chemical container with great care. Avoid toppling, bumping or dragging it.
- (c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.
- (d) Firmly seal the container after use.
- (e) Thoroughly wash your hands and face and rinse out your mouth after using

chemicals.

- (f) Don't eat or drink anything in the working place except in a designated place.
- (g) Don't bring gloves or other contaminated protectors into the rest area.
- (h) Forbid unauthorized entry to the place where chemicals are handled.
- (i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.
- (j) Provide local ventilation in the case of handling chemicals indoors.

(B) Storage precautions

- (a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.
- (b) Use corrosion-resistant containers for storage.

(3) Citric acid /  $\text{HOOCCH}_2\text{C}(\text{OH})(\text{COOH})\text{CH}_2\text{COOH}$

(A) Handling precautions

- (a) Keep away from strong acids and bases.
- (b) Handle the chemical container with great care. Avoid toppling, bumping or dragging it.
- (c) Take care not to cause leak, spillover or spattering. Don't cause dust or vapor.
- (d) Firmly seal the container after use.
- (e) Thoroughly wash your hands and face and rinse out your mouth after using chemicals.
- (f) Don't eat or drink anything in the working place except in a designated place.
- (g) Don't bring gloves or other contaminated protectors into the rest area.
- (h) Forbid unauthorized entry to the place where chemicals are handled.
- (i) Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.
- (j) Provide local ventilation in the case of handling chemicals indoors.

(B) Storage precautions

- (a) Store the container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.
- (b) Use corrosion-resistant containers for storage.



**WARNING**

The chemical agents used for chemical cleaning are harmful to the health. When handling chemicals, wear protective goggles, protective gloves and other protectors. Make sure to check the details of its material safety data sheet (MSDS) beforehand.



**WARNING**

If chemicals should stick to your skin or clothes, immediately wash it away with a large amount of running water.



**WARNING**

If chemicals should enter an eye, immediately wash it away with a large amount of running water and see the doctor.



**WARNING**

Store chemicals in a dark, cold place free from direct sunlight.



**WARNING**

Use the chemicals storage tanks made of the material suitable for each chemical to prevent corrosion.



**WARNING**

Never mix sodium hypochlorite with heavy metals or acids. The mixture with an acid generates toxic chlorine gas.



**WARNING**

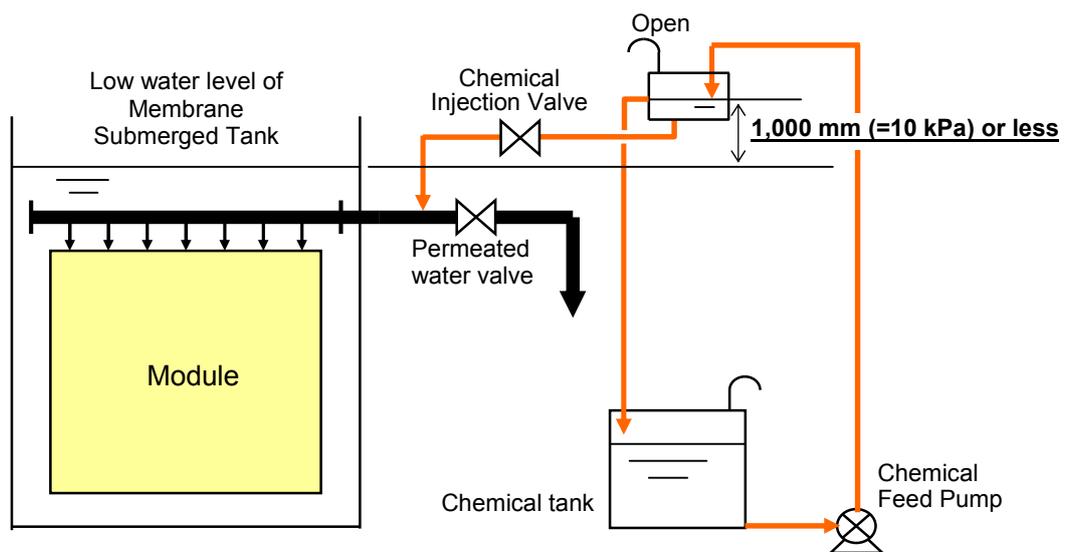
Never mix sodium hypochlorite with oxalic acid or citric acid. Such mixture generates toxic chlorine gas.

## 6. Chemical Cleaning Procedure

### (1) Element Chemical Cleaning Procedure

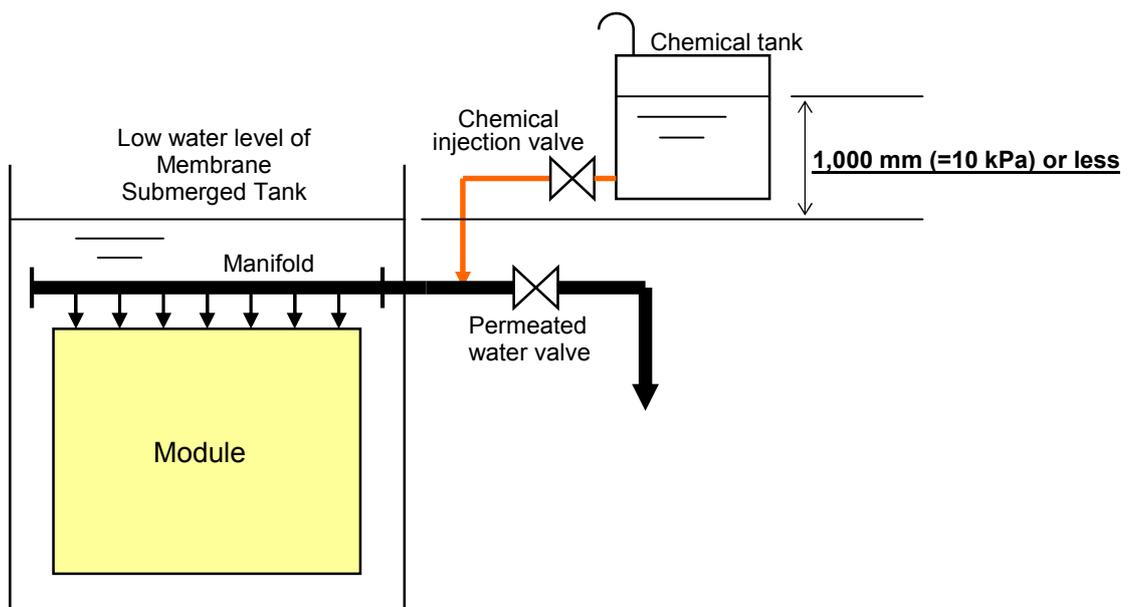
Firstly please slowly inject the chemical via the permeated water nozzle into the elements until it percolates through the membranes. Do not apply too high pressure (>10 kPa or 100 mbar) when injecting the chemical. Some injecting methods are shown below.

- a. Chemical cleaning with the chemical tank located at the bottom (Fig.VIII-2)
    - (i) Confirm that the chemical injection valve is closed and that the chemical feed pump is stopped.
    - (ii) Provide the chemical tank with specified amounts of chemical.
    - (iii) Stop filtration, stop aeration and close the permeated water valve.
    - (iv) Start the chemical feed pump and check that the chemical circulates.
    - (v) Slowly open the chemical injection valve to start injecting the chemical.
    - (vi) After injecting the specified amount of chemicals to the elements, stop the chemical feed pump.
    - (vii) Hold the equipments for 1 to 3 hours.
    - (viii) Close the chemical valve, open the permeated water valve, and start aeration. Then, restart filtration operation.
- \* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.



**Fig.VIII-2 Chemical Cleaning with Chemical Tank Located at Bottom**

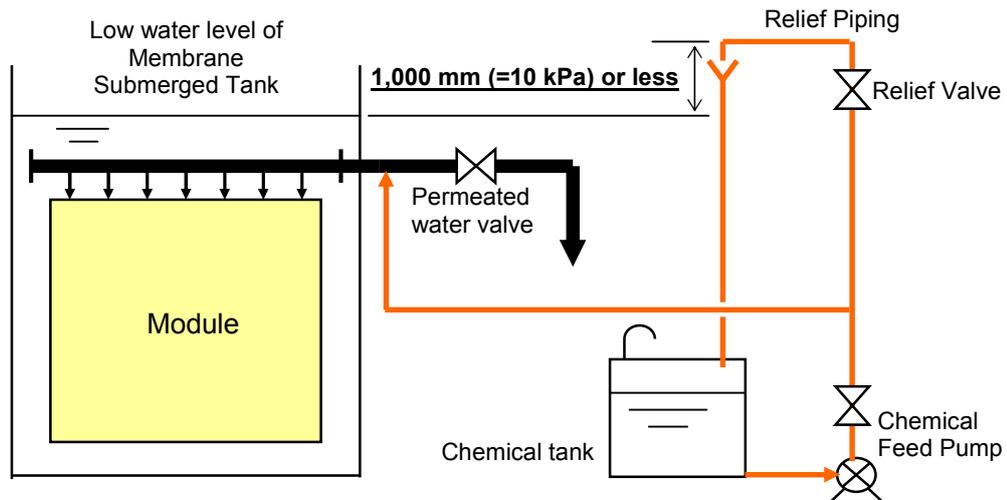
- b. Chemical cleaning with the chemical tank located above the membrane submerged tank (Fig.VIII-3)
- (i) Confirm that the chemical injection valve is closed.
  - (ii) Provide the chemical tank with specified amounts of the chemical.
  - (iii) Stop filtration, stop aeration, and close the permeated water valve.
  - (iv) Slowly open the chemical injection valve to inject chemicals.
  - (v) After injecting the chemical, hold the equipment for 1 to 3 hours.
  - (vi) Close the chemical valve, open the permeated water valve, and start aeration. Then, restart filtration operation.
- \* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.



**Fig.VIII-3 Chemical Cleaning with Chemical Tank Located above Membrane Submerged Tank**

- c. Chemical cleaning with the chemical feed pump and relief valve (Fig.VIII-4)
- (i) Confirm that the chemical feed pump is stopped and the top of relief piping is located at 1 m or lower height from membrane submerged tank water level.
  - (ii) Provide the chemical tank with specified amounts of chemical.

- (iii) Stop filtration, stop aeration and close the permeated water valve.
  - (iv) Surely open the relief valve.
  - (v) Start the chemical feed pump.
  - (vi) Confirm the smooth return of the chemical to Chemical tank when it spouts from the outlet of relief piping. If the spouting is too much, adjust the feeding rate of chemical.
  - (vii) After injecting the specified amount of chemicals to the elements, stop the chemical feed pump.
  - (viii) Hold the equipments for 1 to 3 hours.
  - (ix) Close the relief valve, open the permeated water valve, and start aeration. Then, restart filtration operation.
- \* The chemical may remain in the permeated water in an early stage of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank, or dispose of it in accordance with applicable legal standards for waste disposal. Before restarting the normal operation, check the pH and/or Cl concentration of the permeated water.



**Fig.VIII-4 Chemical Cleaning with the Chemical Feed Pump and Relief Valve**



If chemical is injected without opening relief valve, the internal pressure of the elements will increase and the elements will get damaged. Be sure to open the relief valve before injecting chemical.



Chemical may spout from relief piping. Adjust the chemical feeding rate not to let it spout out of the piping and keep away from relief piping when the chemical feed pump is running. Use the safety protectors such as goggles and gloves.

(2) Precautions for Element Chemical Cleaning

- a. Keep the injecting pressure below 10 kPa (100 mbar). Avoid forcibly applying pressure directly with the pump or by any other means. A higher pressure will damage membrane elements and modules. Please note that injecting pressure may rise up after injecting half of the chemical.
- b. Submerge the module completely in the tank and inject chemical. Please maintain the top of the module at least 500 mm below the liquid surface for the safety reason.
- c. Though higher temperature gives more effective cleaning, please maintain the temperature below 40 degree C. Conversely, lower temperature causes poorer cleaning effects and hampers the recovery of the membrane permeability. Please try to maintain the temperature of the liquid as high as possible within the range below 40 degree C.
- d. After chemical cleaning, a small amount of chemical remains inside the elements and the permeate water line. When resuming the filtration operation, please send back the permeated water to the raw water tank until the permeated water is free from effects of the chemical (for a period of at least 2 intermittent cycles), or dispose of it in accordance with applicable legal standards for waste disposal.
- e. If sodium hypochlorite cleaning is immediately followed by acid cleaning or in reverse order, do make sure that the both chemicals are never mixed at any tank or pipe (especially injection line). Otherwise such mixture generates toxic chlorine gas.
- f. If permeate is used as cleaning solution make up water, residual calcium in the make up water may precipitate when sodium hypochlorite is mixed into the water. If a high calcium concentration is expected in the make up water, confirm the possibility of precipitation by a bench-scale sodium hypochlorite addition test and if whitish precipitation of calcium is found, use tap water for the make up water.



If an abnormality is found in the equipment during chemical cleaning, immediately stop the operation.



Never mix sodium hypochlorite with oxalic acid or citric acid. Such mixture generates toxic chlorine gas.



If chemical is injected forcibly directly with the chemical feed pump or by any other means, the internal pressure of the elements will increase and the elements will get damaged. Be sure to inject chemical with the pressure of lower than 10 kPa (100 mbar).



Before starting injecting chemical to elements, confirm that the liquid surface is more than 500 mm higher than the top of the module.



Stop the aeration during chemical cleaning, or the membrane may get damaged.

## 7. Lifting Procedure

Please take the following steps to lift “TMR140 Series” modules for maintenance.

- (1) If guide rail system is not installed in the membrane tank, drain the activated sludge from membrane tank.
- (2) Disconnect the manifold from the permeate water line and disjoint the bolts jointing the element block with the aeration block in case bolts/nuts are applied for connecting both blocks. When lifting the element block of TMR140-200W, please disconnect one manifold from the other. And you can lift up the element block using chains or slings.
- (3) Hook the chain/sling attached with element block to the lifting device, and you can lift up the element blocks using chains/slings.



When lifting “TMR140 Series”, please attach chains or slings to it and lift it straight upward calmly to prevent “TMR140 Series” from shaking. Never allow any person under “TMR140 Series”.



Use chains or slings compatible with lifting weight.



Check the condition of each part before lifting and never use damaged one. Never stand below the membrane module when lifting. Be careful of the balance of the module when lifting.



When lifting TMR140-200D or 400DW, do not lift upper element blocks and lower element blocks all together. Upper/lower element block has to be lifted separately.

## 8. Storage Products after Use

Please take the following steps to preserve the used “TMR140 Series” modules for a long time until future re-operation.

- (1) Drain the sludge in the membrane submerged tank.
- (2) Clean the modules with clear water and wash out the remaining sludge on the module surface as well as tank wall using hose. Never apply high pressure washing machine.
- (3) Fill the clear water into the tank to let the modules completely submerged and maintain its water level until the next start up.
- (4) Periodical dosing of sodium hypochlorite helps inhibit the growth of algae/microorganism during the storage, however hypo concentration in the tank has to be low (<50 ppm) to prevent from possible damage to the module (stainless steel) by long-time exposure.
- (5) In case aeration of the tank is required, its duration shall be short enough (<5 minutes per hour) to avoid putting stress to membrane elements by “aeration without filtration”.
- (6) Before re-commissioning of the modules, it is strongly recommended to conduct chemical cleaning to the modules for the sake of removing biofilm grown on the membrane surface and piping.

In case storage period is not long (within 24 hours), periodical sprinkling of water to modules especially membrane surface and putting non-transparent sheet onto the modules for protection against direct sunlight and wind are effective for creating wet condition of membrane.



Keep the membrane wet once it gets wet with operation. If that membrane gets dried up, its permeability may be decreased seriously.

## 9. Disposing Procedure

When disposing of the membrane after use, please follow below general procedure.

- (1) Clean up the membrane module with water. After that it is better to dry up the module for your easy handling.
- (2) Dispose of the module or each constituent following local regulation for waste disposal (landfill, incineration...). When required by regulation, disassemble the module and segregate its constituent accordingly (e.g. combustible/incombustible).
- (3) Regarding membrane, do not burn it without appropriate facilities since harmful Hydrogen Fluoride (HF) gas will be generated during incineration. If it needs to be incinerated, please apply a service of a qualified waste disposing company.



### **WARNING**

Don't burn the membranes without appropriate facilities since harmful Hydrogen fluoride (HF) gas is generated at burning. When dispose membranes, please apply a service of a qualified waste disposing company.

## IX. REPLACEMENT PARTS LIST

Please contact TORAY for the details of the specifications..

### (1) TMR140-050S

Name	Frequency	Type No. of replacement parts	Required Quantity per Module <b>TMR140-050S</b>
Permeate Tube	Every 3 years or when deterioration detected,	EBL-TUBE-050 (50pcs set)	1
		EBL-TUBE-100 (100pcs set)	-
Element Fixing Gasket (Middle Part of Element Block)	Every 3 years or when deterioration detected, whichever comes first.	GASKET140-050M	1
Element Fixing Gasket (Side Part of Element Block)		GASKET140-050S	2
Element or Element Block	Once 3 to 7 years	TSP-50150 (Element) or EBL140-050S (Element Block)	TSP-50150 x 50 or EBL140-050S x 1

### (2) TMR140-100S

Name	Frequency	Type No. of replacement parts	Required Quantity per Module <b>TMR140-100S</b>
Permeate Tube	Every 3 years or when deterioration detected,	EBL-TUBE-050 (50pcs set)	-
		EBL-TUBE-100 (100pcs set)	1
Element Fixing Gasket (Middle Part of Element Block)	Every 3 years or when deterioration detected, whichever comes first.	GASKET140-100M	1
Element Fixing Gasket (Side Part of Element Block)		GASKET140-100S	2
Element or Element Block	Once 3 to 7 years	TSP-50150 (Element) or EBL140-100S (Element Block)	TSP-50150 x 100 or EBL140-100S x 1

### (3) TMR140-200W

Name	Frequency	Type No. of replacement parts	Required Quantity per Module <b>TMR140-200W</b>
Permeate Tube	Every 3 years or when deterioration detected,	EBL-TUBE-050 (50pcs set)	-
		EBL-TUBE-100 (100pcs set)	2
Element Fixing Gasket (Middle Part of Element Block)	Every 3 years or when deterioration detected, whichever comes first.	GASKET140-100M	2
Element Fixing Gasket (Side Part of Element Block)		GASKET140-100S	4
Element or Element Block	Once 3 to 7 years	TSP-50150 (Element) or EBL140-100W (Element Block)	TSP-50150 x 200 or EBL140-100W x 2

### (4) TMR140-200D

Name	Frequency	Type No. of replacement parts	Required Quantity per Module <b>TMR140-200D</b>
Permeate Tube	Every 3 years or when deterioration detected,	EBL-TUBE-050 (50pcs set)	-
		EBL-TUBE-100 (100pcs set)	2
Element Fixing Gasket (Middle Part of Element Block)	Every 3 years or when deterioration detected, whichever comes first.	GASKET140-100M	2
Element Fixing Gasket (Side Part of Element Block)		GASKET140-100S	4
Element or Element Block	Once 3 to 7 years	TSP-50150 (Element) or EBL140-100S (Element Block)	TSP-50150 x 200 or EBL140-100S x 2

### (5) TMR140-400DW

Name	Frequency	Type No. of replacement parts	Required Quantity per Module <b>TMR140-400DW</b>
Permeate Tube	Every 3 years or when deterioration detected,	EBL-TUBE-050 (50pcs set)	-
		EBL-TUBE-100 (100pcs set)	4
Element Fixing Gasket (Middle Part of Element Block)	Every 3 years or when deterioration detected, whichever comes first.	GASKET140-100M	4
Element Fixing Gasket (Side Part of Element Block)		GASKET140-100S	8
Element or Element Block	Once 3 to 7 years	TSP-50150 (Element) or EBL140-100S (Element Block)	TSP-50150 x 400 or EBL140-100S x 4

## X. TROUBLESHOOTING

Most of the troubles in the operation of “TMR140 Series” are related to abnormal membrane scouring aeration, too late chemical cleaning, lack of maintenance of the pretreatment system. The following table shows such troubles and corrective actions against them:

**Table X-1 Troubleshooting**

Problem		Cause	Action
1	The air diffusion rate is below the standard level.	The blower is broken	Check the blower.
		The air diffusers are clogged.	Clean the air diffusers.
2	The air diffusion is uneven in the module or between modules.	The air diffusers on the module are clogged.	Clean the air diffusers on the module.
		The bottom of the element block is stuck with trash.	Check the pretreatment system. Inspect the module. Correct operation and maintenance works of the pretreatment system.
3	The permeated water flow rate has decreased. Or the trans-membrane pressure has increased.	Membrane clogging has worsened.	Carry out chemical cleaning.
		Sludge accumulated on the membrane surface because of uneven air diffusion	Inspect the blower and clean the air diffusers to improve air diffusion. Carry out chemical cleaning.
		Abnormal properties of sludge have worsened its filterability.	Improve sludge properties. <ul style="list-style-type: none"> <li>Adjust the excess sludge discharge rate.</li> <li>Prevent entry of abnormal components, such as oils.</li> <li>Adjust the BOD load.</li> <li>Adjust the raw water quality (add nitrogen, phosphorous, etc.)</li> </ul>
4	The concentration of suspended solids in the permeate water has increased.	An element or tube has fractured.	Seal the element and manifold nozzle <sup>*1</sup> .
		A leakage has occurred in the permeated water piping.	Inspect the faulty part <sup>*2</sup> and correct the fault.
		Germes are generated on the membrane or the permeate line.	To clean the permeated water piping, inject into it a sodium hypochlorite solution with an effective chlorine concentration of 100 to 200 mg/L.

\*1: Even if a cause is found in the tube, there still is the possibility of contamination inside the element. Thus, seal the element and manifold nozzle.

\*2: To check the piping joints and welds for leakage with a pressure being applied, be careful not to apply pressure to the membrane modules.

## **XI. APPENDIX**

Following information is provided in the separate-attached document:

- (1) Assembly of Modules
- (2) Assembly of Guide Rail System
- (3) Assembly of Hangers.
- (4) Procedure of Paper filter test.

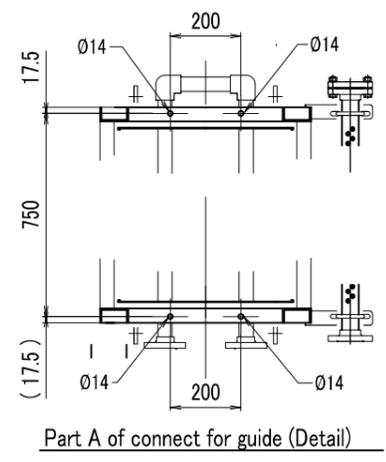
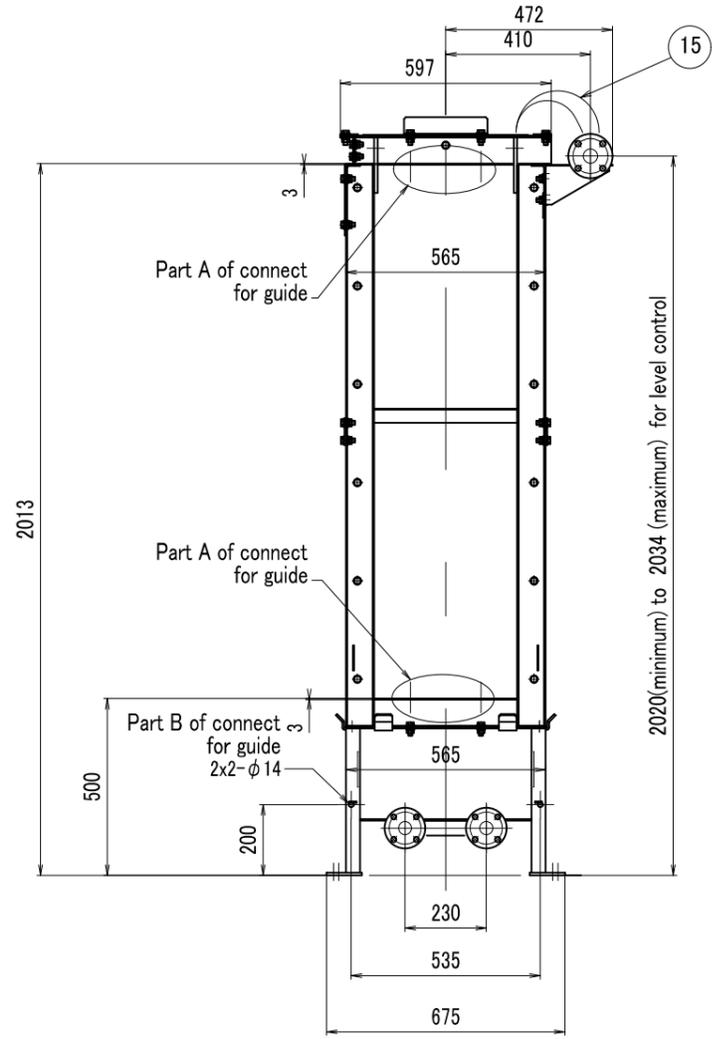
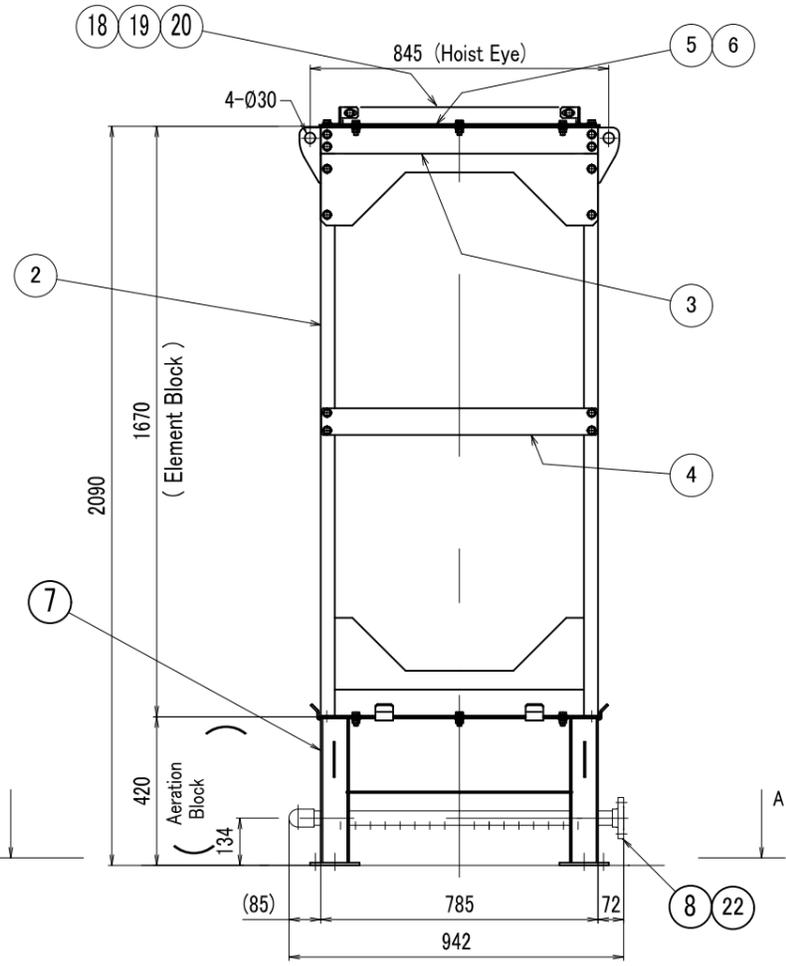
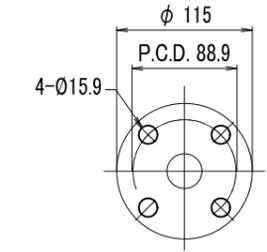
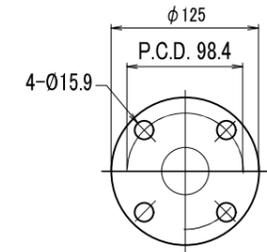
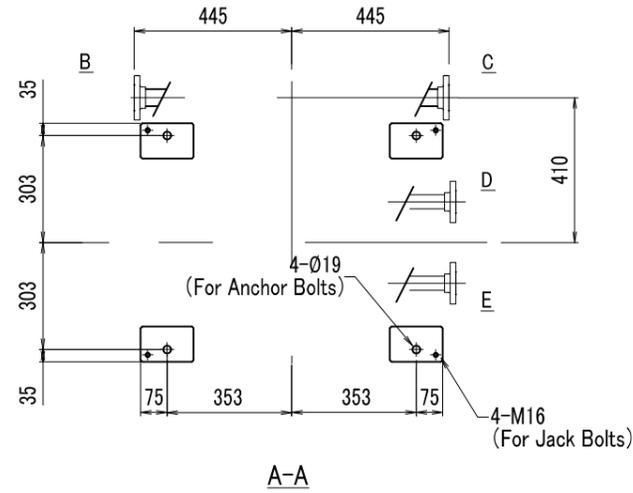
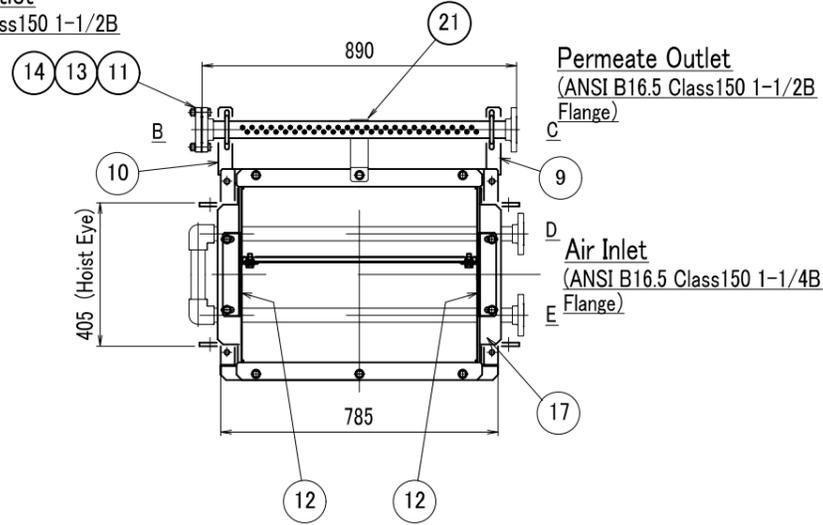
This Instruction Manual does not intend to guarantee the results of application of the information provided herein or the safety and the compatibility of this product. Before using this product, the user is asked to check for its safety and compatibility with the intended purpose.  
The content of this Instruction Manual is subject to revision from time to time.  
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NO.	DRWG. NO.	NAME	MATL.	SPEC.	G1	G2	G3	G4
1	-07-020	Assembly			0			
2	-06-143	Element Flame	SUS316L		1			
3	-05-272	Channel	SUS316L		1			
4	-05-273	FB	SUS316L		2			
5	-06-011	Element Holder	SUS316L		2			
6	-06-010	Rubber	EPDM		2			
7	-10-001	Aeration Flame	SUS316L		1			
8	-10-120	Diffuser	PP	ANSI B16.5 Class150 1-1/4B	1			
9	-05-226	Bracket	SUS316L		1			
10	-05-226	Bracket	SUS316L		1			
11	-10-130	Permeate Manifold	PP	ANSI B16.5 Class150 1-1/2B	1			
12	-05-220	Side Panel	SUS316L		2			
13	-10-133	Blind Flange	PP	ANSI B16.5 Class150 1-1/2B (with gasket)	1			
14	-10-135	Gasket *2	EPDM	1-1/2B	2			
15		Tube	PU		50			
16		Element	ABS	TSP-50150	50			
17	-06-142	Angle	SUS316L		2			
18	-08-010	Comb holder	SUS316L		1			
19	-08-006	Bracket	SUS316L		2			
20	-08-011	Comb	EPDM		1			
21	-10-002	Center Bracket	SUS316L		1			
22	-10-125	Gasket *2	EPDM	1-1/4B	2			

**Permeate Outlet**  
 (ANSI B16.5 Class150 1-1/2B  
 Flange)



**TMR140-50S Specification** \*1

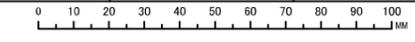
Type	TMR140-50S
Membrane Material	PVDF (polyvinylidene fluoride)
The Number of Element [UN]	50
membrane Area [m <sup>2</sup> ]	70
Aeration Block Weight [kg]	25
Element Block Weight(dry) [kg]	355
Element Block Max Weight (wet) [kg]	690

\*1 :The content of this specification is subject revision without notice.  
 \*2 :Dedicated gasket with special shape.

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED	TORAY INDUSTRIES, INC.		TMR140-050S ASSEMBLY	
PROJECT MANAGER	JAPAN		EBL140-050SA6LP	
MECHANICAL	SCALE 1/10	DATE 2010.07.31	ABL-050S2A6LP	
INSTRUMENTAL	DRAWN J.Itakura	DESIGNED	ORDER No.	DRWG.No.
ELECTRICAL	CHECKED K.Sakai	APPROVED K.Yokogawa	SS-08-153-2	
ENG.DEPT MANAGER				



A-1  
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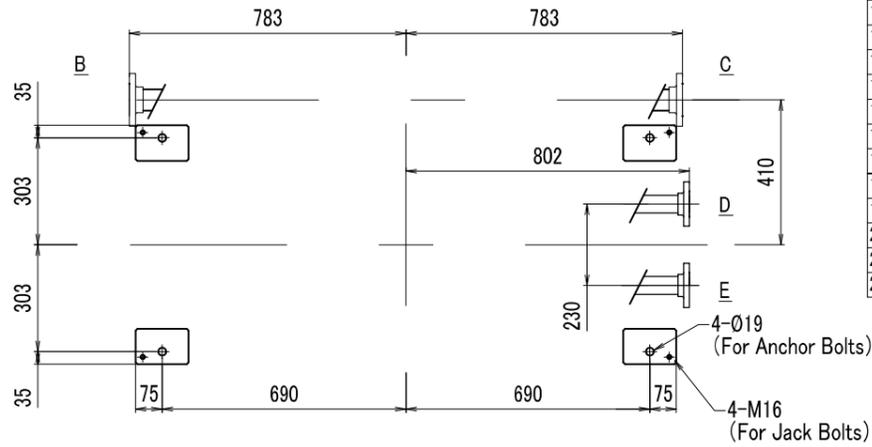
**CONFIDENTIAL**

NO.	DRWG. NO.	NAME	MATL.	SPEC.	G1	G2	G3	G4
1	-07-020	Assembly			0			
2	-06-143	Element Flame	SUS316L		1			
3	-05-272	Channel	SUS316L		1			
4	-05-273	FB	SUS316L		2			
5	-06-011	Element Holder	SUS316L		2			
6	-06-010	Rubber	EPDM		2			
7	-10-015	Aeration Flame	SUS316L		1			
8	-10-100	Diffuser	PP	ANSI B16.5 Class150 1-1/2B	1			
9	-05-226	Bracket	SUS316L		1			
10	-05-226	Bracket	SUS316L		1			
11	-10-090	Permeate Manifold	PP	ANSI B16.5 Class150 2B	1			
12	-05-220	Side Panel	SUS316L		2			
13	-10-093	Blind Flange	PP	ANSI B16.5 Class150 2B	1			
14	-10-094	Gasket *2	EPDM	2B	2			
15		Tube	PU		100			
16		Element	ABS	TSP-50150	100			
17	-06-142	Angle	SUS316L		2			
18	-08-010	Comb holder	SUS316L		1			
19	-08-006	Bracket	SUS316L		2			
20	-08-011	Comb	EPDM		1			
21	-10-016	Center Bracket	SUS316L		1			
22	-10-135	Gasket *2	EPDM	1-1/2B	2			

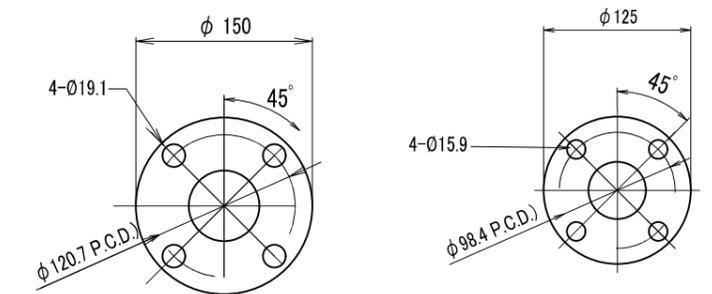
Permeate Outlet  
 (ANSI B16.5 Class150 2B Flange)

Permeate Outlet  
 (ANSI B16.5 Class150 2B Flange)

Air Inlet  
 (ANSI B16.5 Class150 1-1/2B)



A-A



Permeate Flange(1/3)

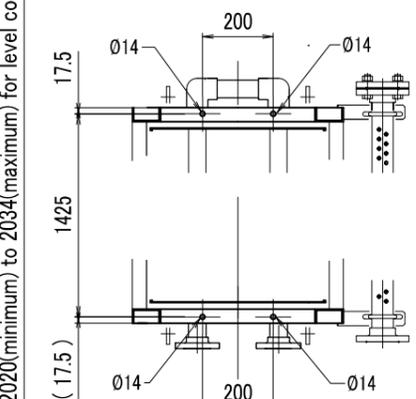
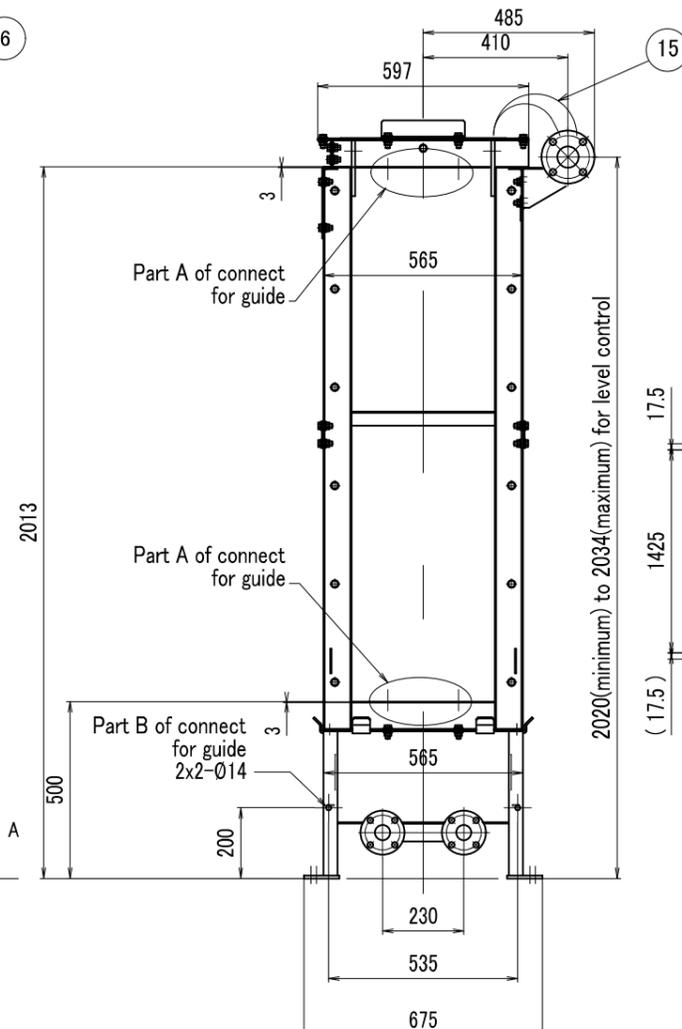
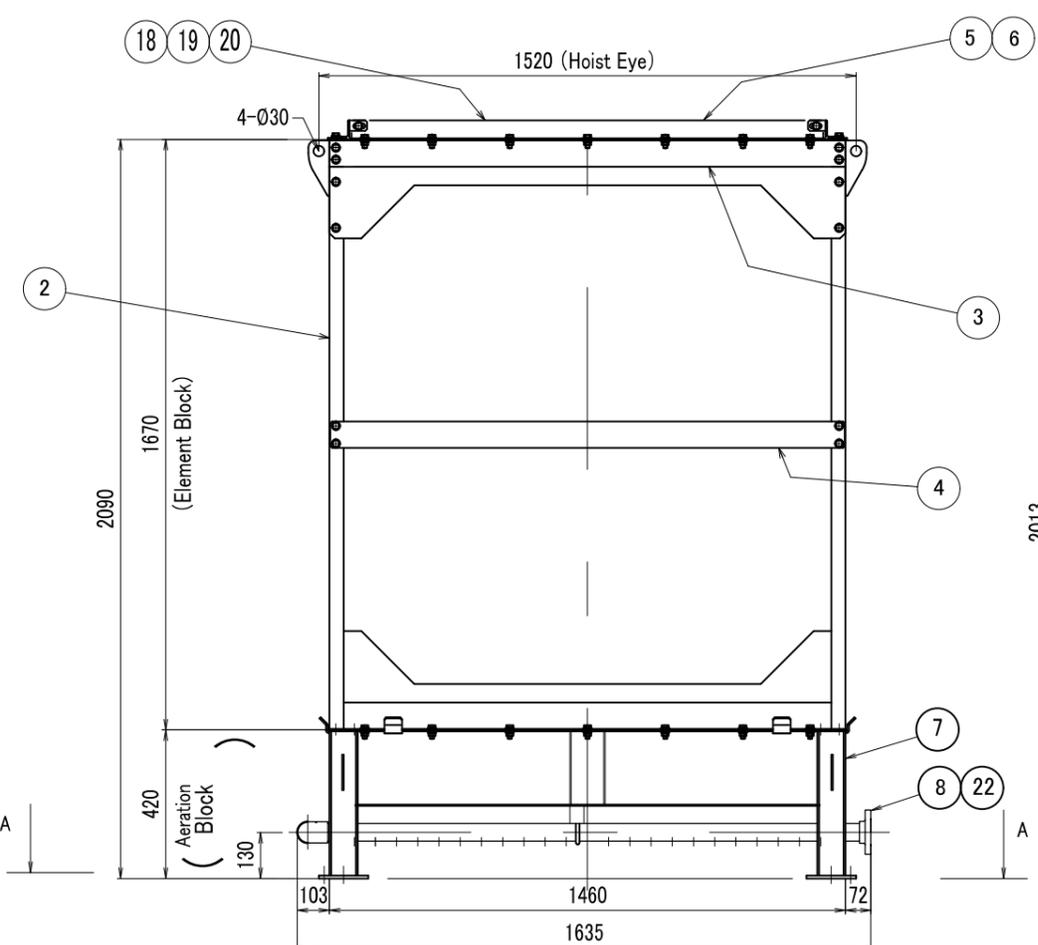
Air Flange(1/3)

TMR140-100S Specification \*1

Type	TMR140-100S
Membrane Material	PVDF (polyvinylidene fluoride)
The Number of Element [UN]	100
membrane Area [m2]	140
Aeration Block Weight [kg]	40
Element Block Weight(dry) [kg]	620
Element Block Max Weight (wet) [kg]	1240

\*1 :The content of this specification is subject revision without notice.

\*2 :Dedicated gasket with special shape.

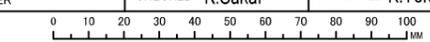


Part A of connect for guide (Detail)

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED	TORAY INDUSTRIES, INC.		TMR140-100S ASSEMBLY	
PROJECT MANAGER	JAPAN		EBL140-100SA6LP	
MECHANICAL	SCALE 1/10	DATE 2010.7.31	ABL-100S2A6LP	
INSTRUMENTAL	DRAWN J.Itakura	DESIGNED	ORDER No.	DRWG.No.
ELECTRICAL	CHECKED K.Sakai	APPROVED K.Yokogawa		SS-08-157-2
ENG.DEPT MANAGER				

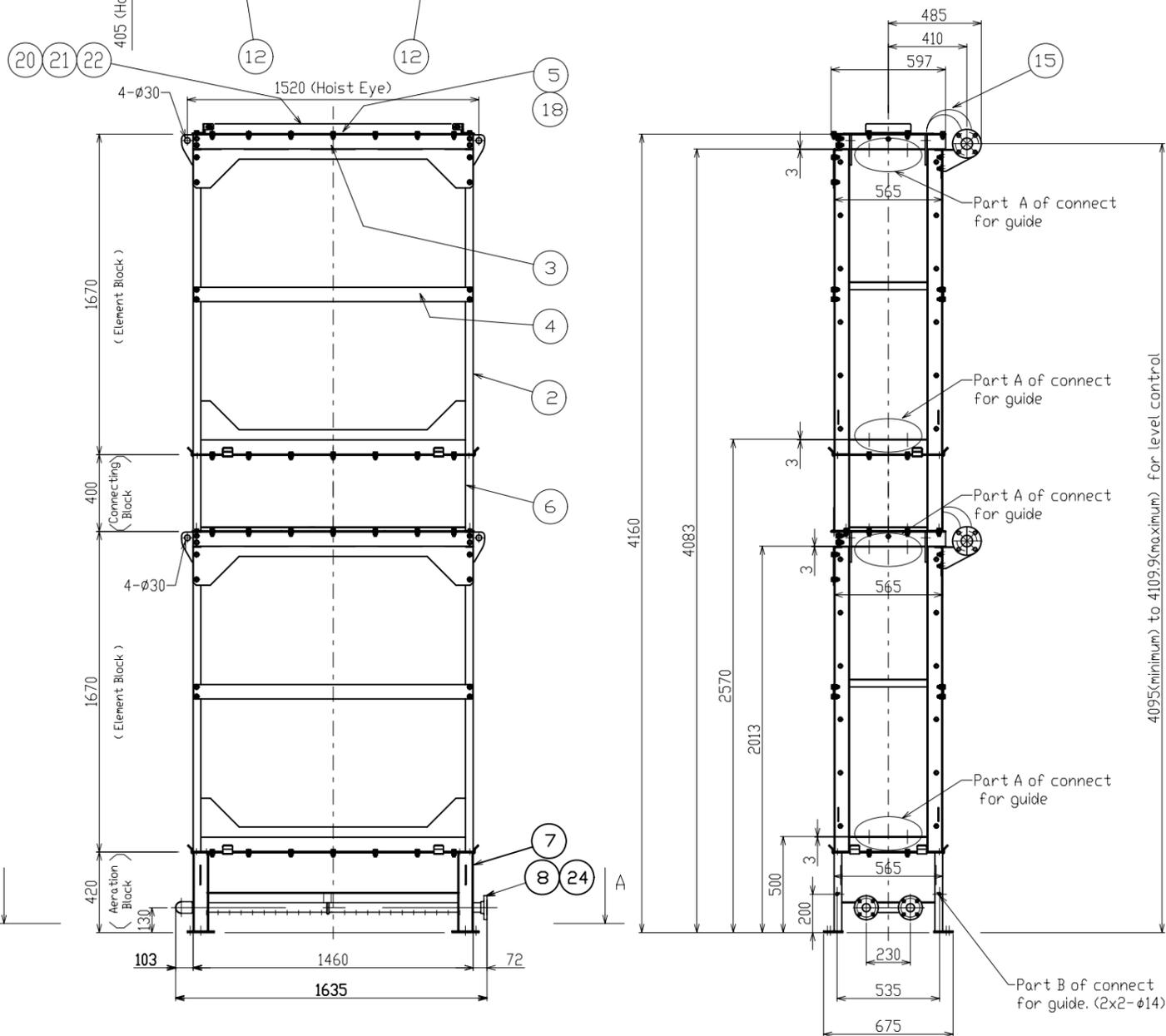
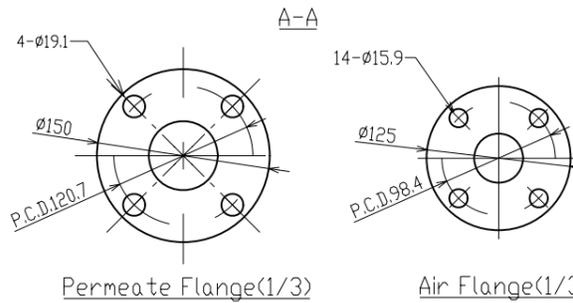
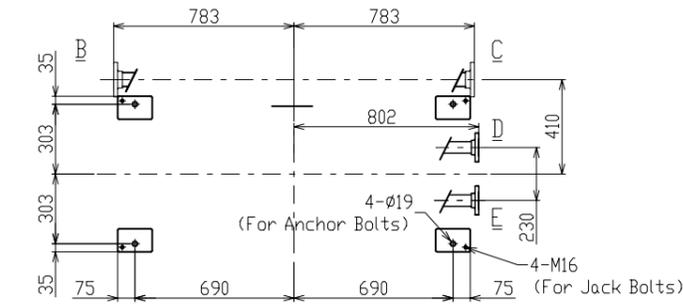
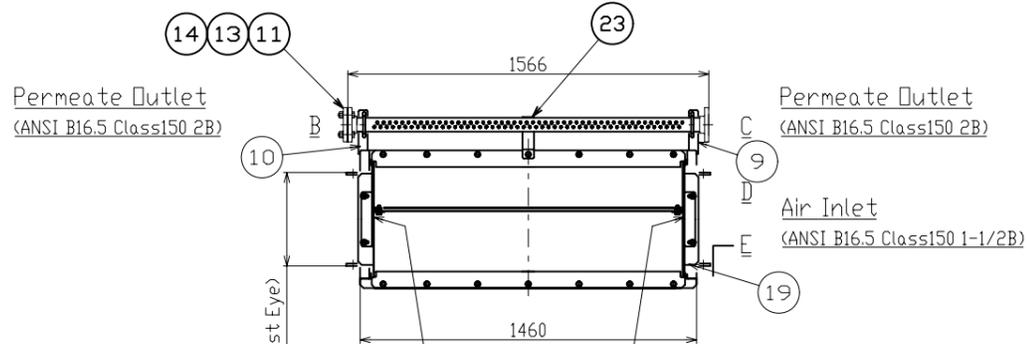


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**CONFIDENTIAL**

NO.	DRWG. NO.	NAME	MATL.	SPEC.	REV.			
					G1	G2	G3	G4
1		Assembly			0			
2	-06-140	Element Flange	SUS316L		2			
3	-05-212	Channel	SUS316L		2			
4	-05-213	FB	SUS316L		4			
5	-06-013	Element Holder	SUS316L		4			
6	-07-157	Connecting Block	SUS316L		1			
7	-10-018	Aeration Flange	SUS316L		1			
8	-10-100	Diffuser	PP	ANSI B16.5 Class150 1-1/2B	1			
9	-05-226-01	Bracket	SUS316L		2			
10	-05-226-02	Bracket	SUS316L		2			
11	-10-090	Permeate Manifold	PP	ANSI B16.5 Class150 2B	2			
12	-05-220	Side Panel	SUS316L		4			
13	-10-093	Blind Flange	PP	ANSI B16.5 Class150 2B	2			
14	-10-094	Gasket #2	EPDM	2B	4			
15		Tube	PU		200			
16		Element	ABS	TSP-50150	200			
17	-07-158	Cover	SUS316L		1			
18	-06-006	Rubber	EPDM		4			
19	-07-142	Angle	SUS316L		4			
20	-08-010	Comb Holder	SUS316L		2			
21	-08-006	Bracket	SUS316L		4			
22	-08-011	Comb	EPDM		2			
23	-10-016	Center Bracket	SUS316L		2			
24	-10-135	Gasket #2	EPDM	1-1/2B	2			

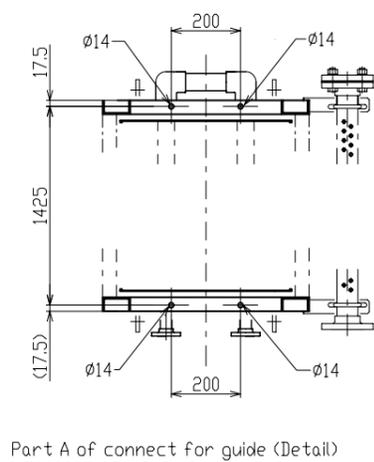


TMR140-200D Specification \*1

Type	TMR140-200D
Membrane Material	PVDF (polyvinylidene fluoride)
The Number of Element [UN]	200
membrane Area [m <sup>2</sup> ]	280
Aeration Block Weight [kg]	55
Element Block Weight(dry) [kg]	1290
Element Block Max Weight (wet) [kg]	2500

\*1 :The content of this specification is subject revision without notice.

\*2 :Dedicated gasket with special shape.

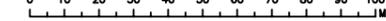


REF. DWG. NO.	TITLE OF REF. DWG.

LET	REVISION	DATE	BY	APPROVED

APPROVED	TORAY INDUSTRIES, INC.	
PROJECT MANAGER	JAPAN	
MECHANICAL	SCALE 1/15	DATE 2010.7.31
INSTRUMENTAL	DRAWN J.Itakura	DESIGNED K.Sakai
ELECTRICAL	CHECKED K.Sakai	APPROVED K.Yokogawa
ENG. DEPT. MANAGER		

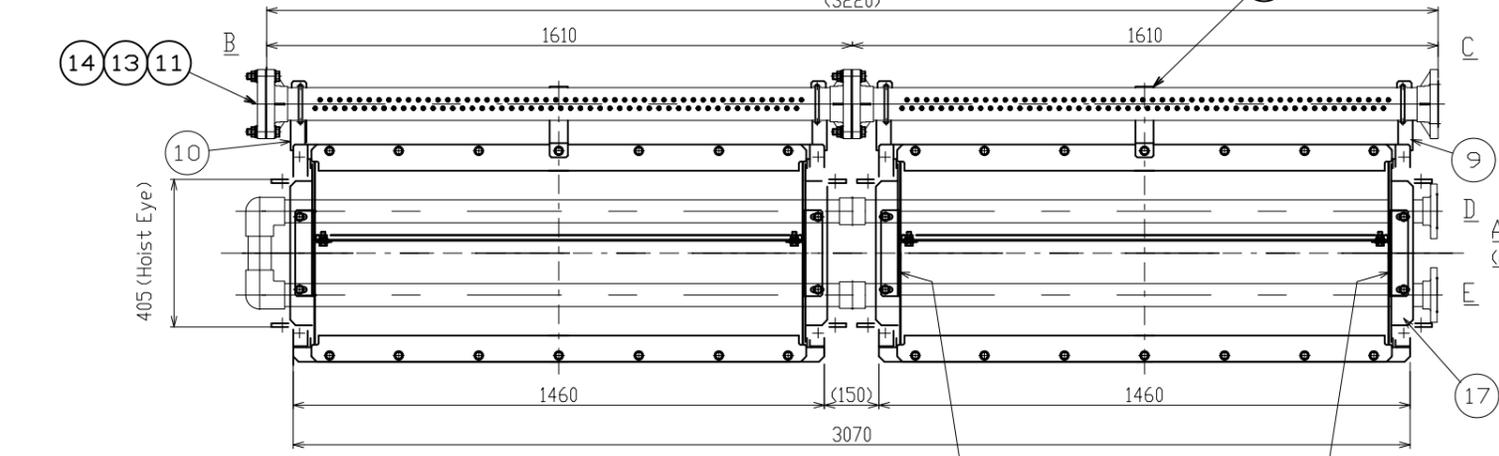
TMR140-200D ASSEMBLY	
EBL140-100SA6LP	
ABL -100SA6LP	
ORDER No.	DRWG. No.
	SS-08-161-2
REV.	ISSUED TO



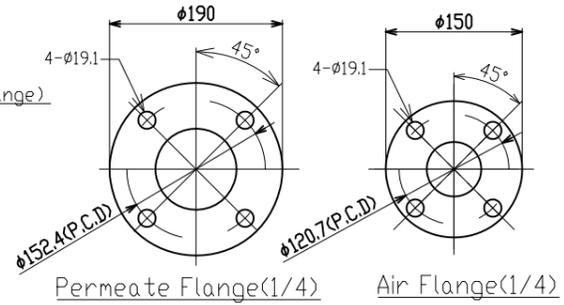
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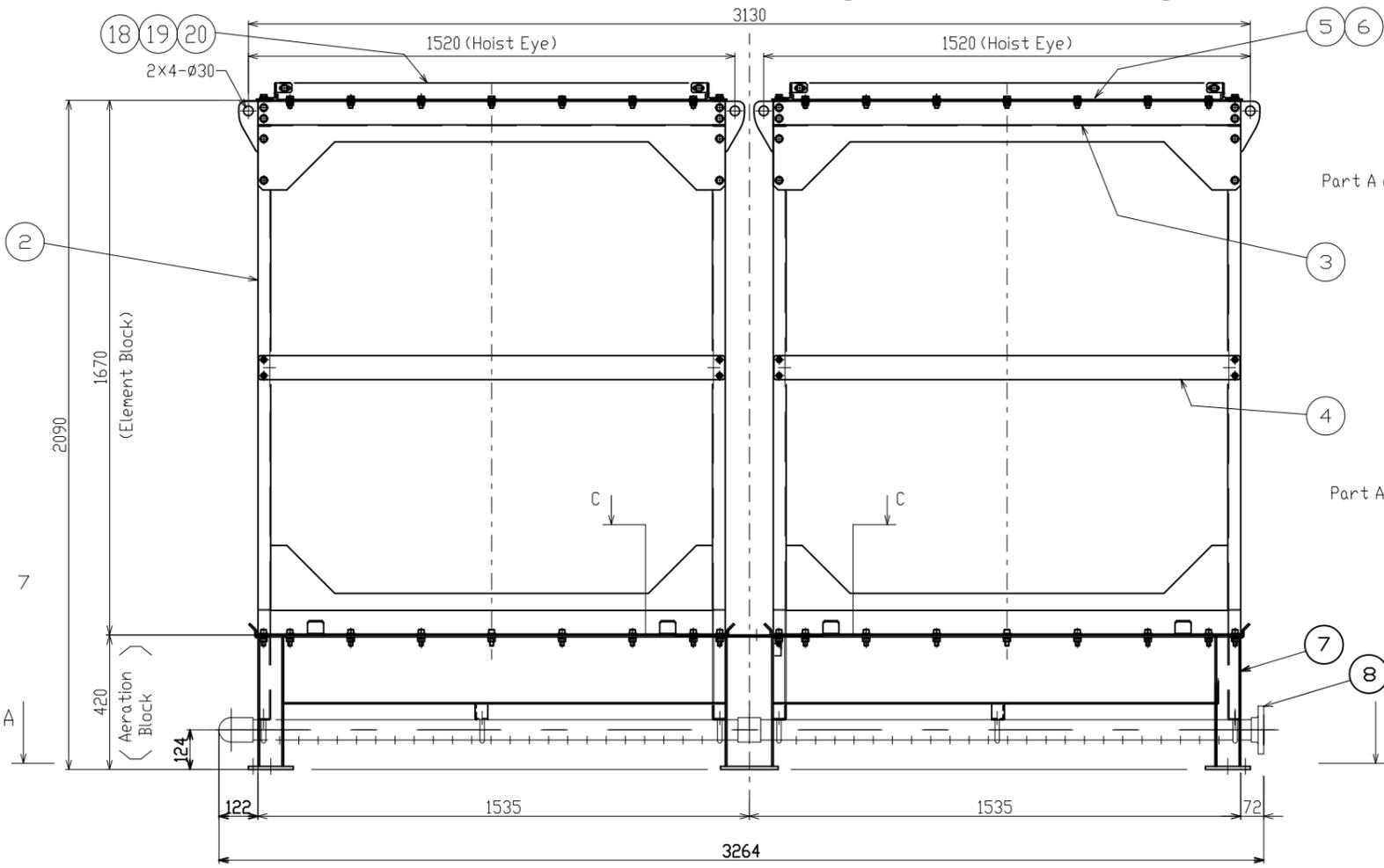
Permeate Outlet  
 (ANSI B16.5 Class150 3B Flange)



Permeate Outlet  
 (ANSI B16.5 Class150 3B Flange)



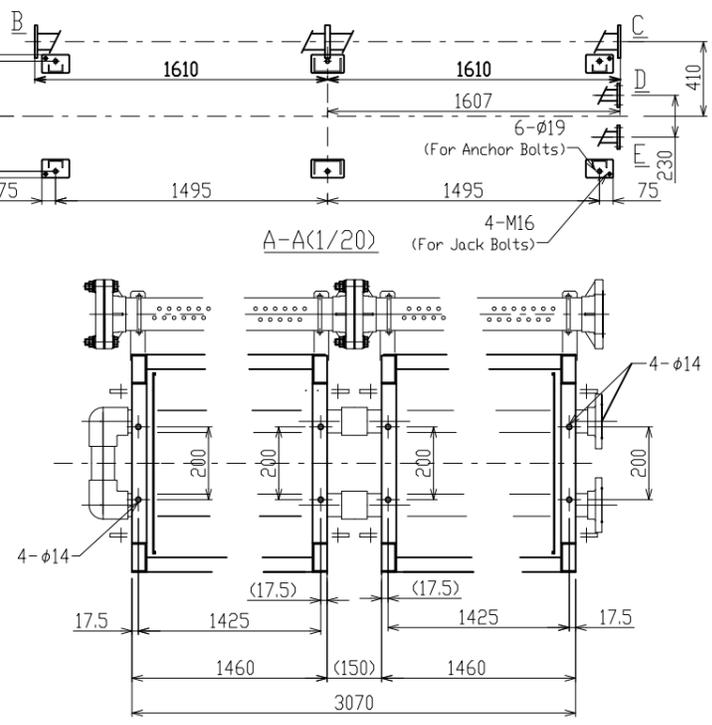
Air Inlet  
 (ANSI B16.5 Class150 2B Flange)



Part A of connect for guide

Part A of connect for guide

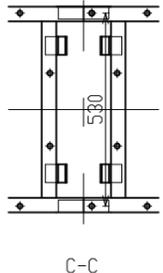
2040(minimum) to 2055(maximum) for level control



Part of connect for guide (detail)  
 TMR140-200W Specification \*1

Type	TMR140-200W
Membrane Material	PVDF (polyvinylidene fluoride)
The Number of Element [UN]	200
membrane Area [m <sup>2</sup> ]	280
Aeration Block Weight [kg]	100
Element Block Weight(dry) [kg]	1240 (620 per Block)
Element Block Max Weight (wet) [kg]	2480 (1240 per Block)

\*1 :The content of this specifidation is subject revision without notice.  
 \*2 :Dedicated gasket with special shape.



C-C

APPROVED	TORAY INDUSTRIES, INC.		TMR140-200W ASSEMBLY	
PROJECT MANAGER	JAPAN		EBL140-100WA6LP	
MECHANICAL	SCALE 1/10	DATE 2010.7.31	ABL -200W2A6LP	
INSTRUMENTAL	DRAWN J.Itakura	DESIGNED	ORDER No.	DRWG.No.
ELECTRICAL	CHECKED K.Sakai	APPROVED K.Yokogawa	SS-08-165-4	REV.
ENG.DEPT MANAGER				

REF.DWG.NO.	TITLE OF REF.DWG.

LET	REVISION	DATE	BY	APPROVED

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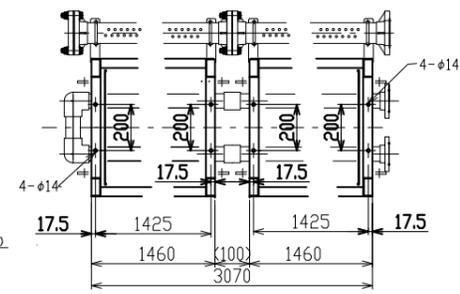
**CONFIDENTIAL**

TMR140-400DW Specification \*1

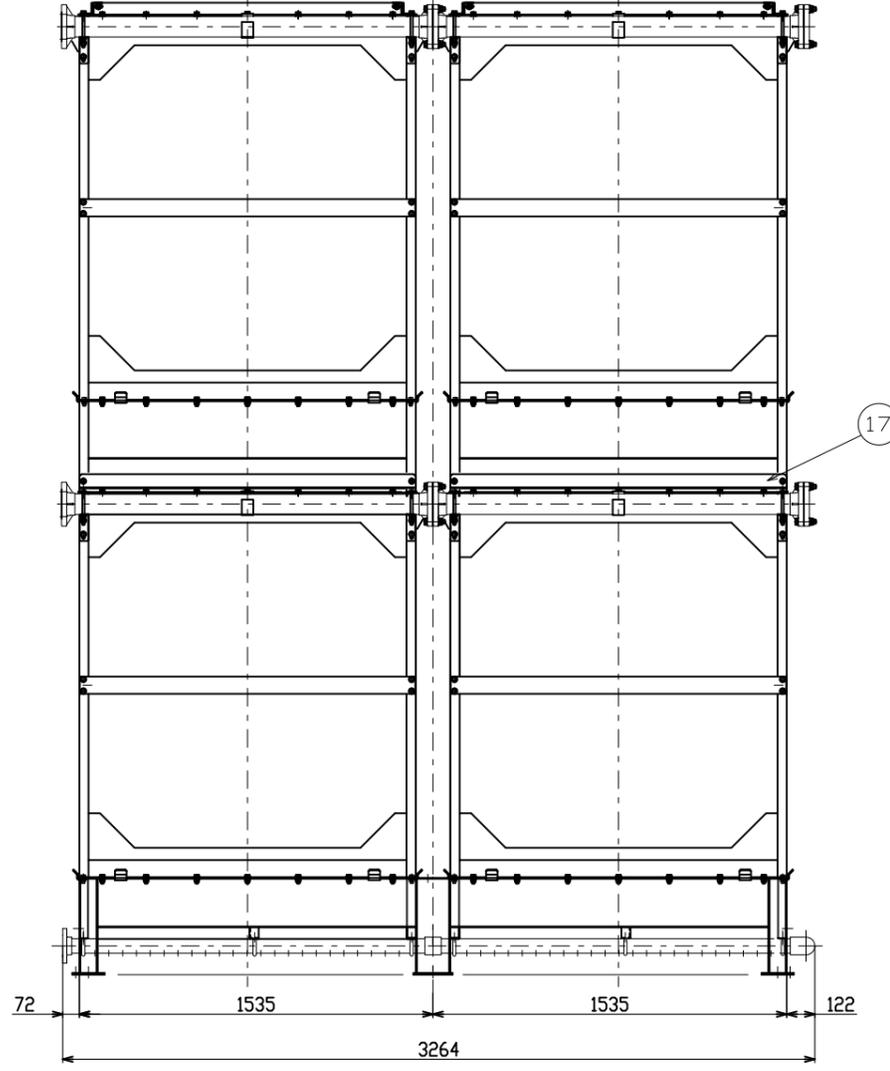
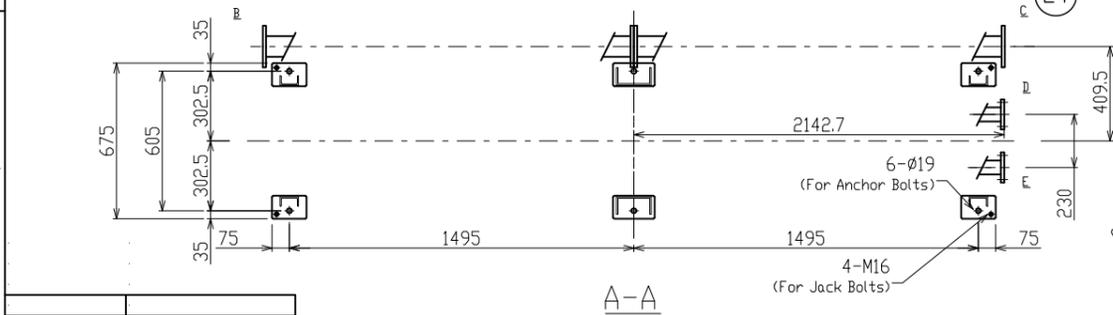
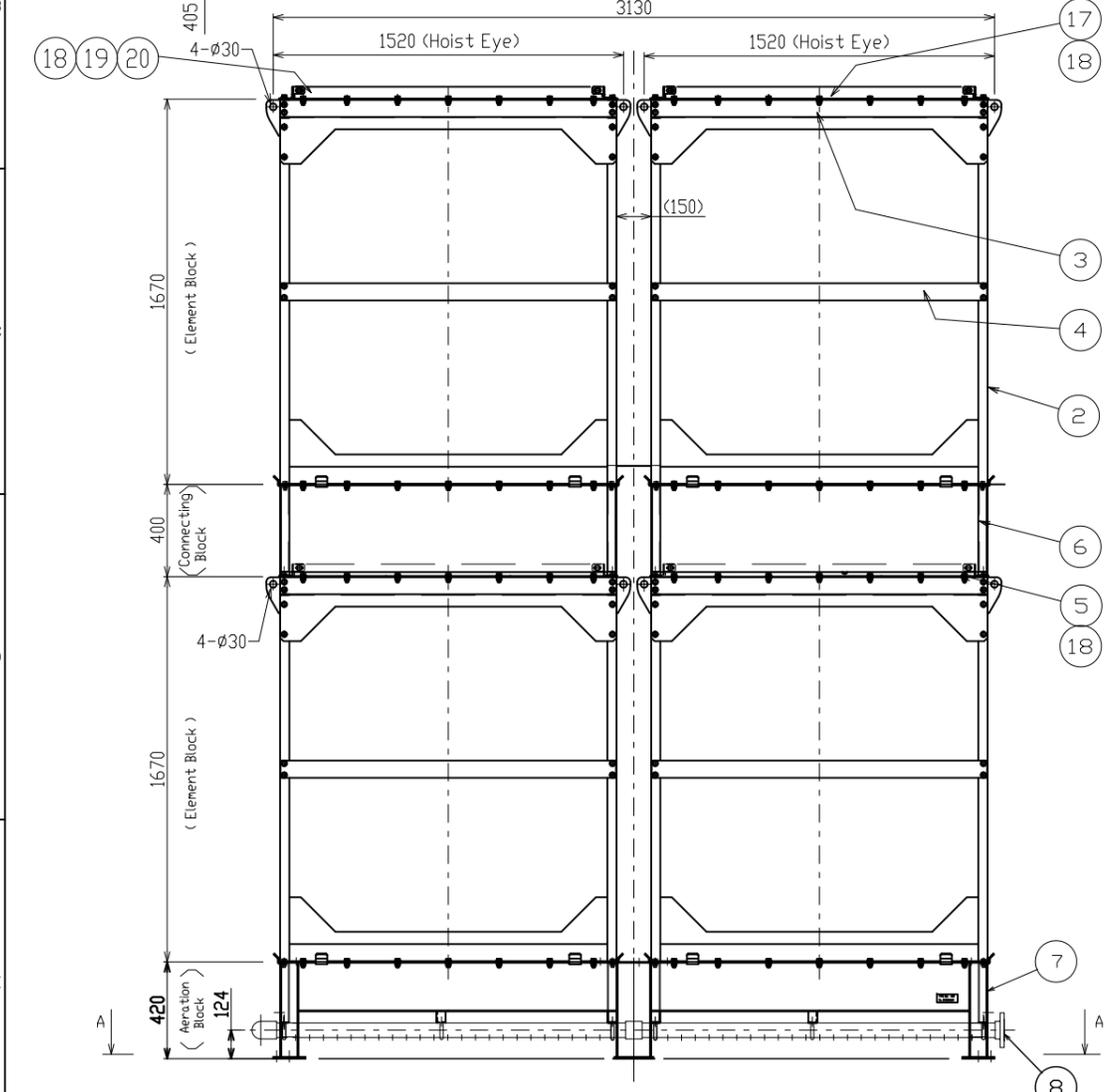
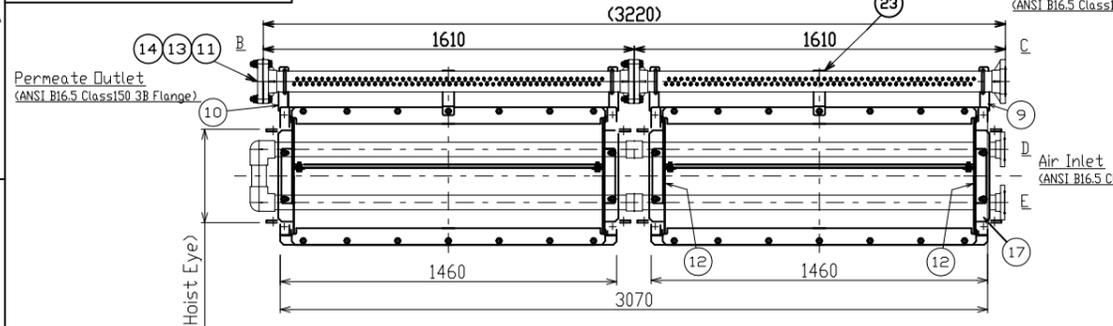
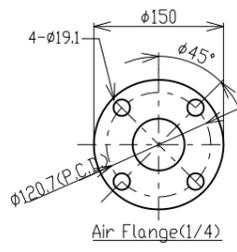
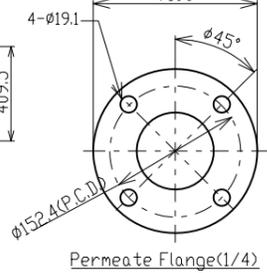
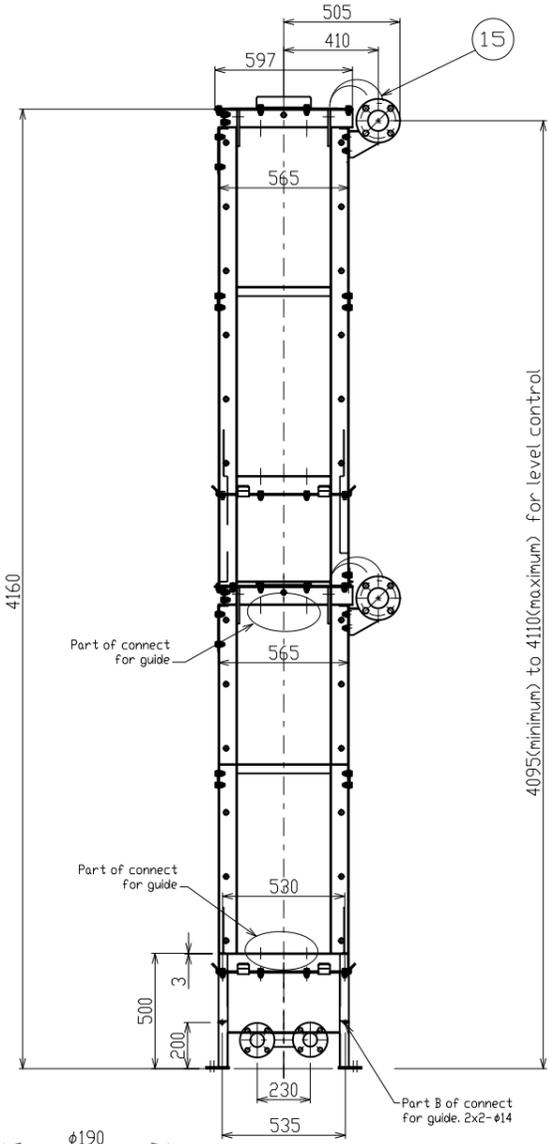
Type	TMR140-400DW
Membrane Material	PVDF (polyvinylidene fluoride)
The Number of Element [UN]	400
membrane Area [m2]	560
Aeration Block Weight [kg]	100
Element Block Weight(dry) [kg]	2480 (620 per Block)
Element Block Max Weight (wet) [kg]	4960 (1240 per Block)

\*1: The content of this specification is subject  
 revision without notice.  
 \*2: Dedicated gasket with special shape.

NO.	DRWG.NO.	NAME	MATL.	SPEC.	G1	G2	G3	G4
1	-06-031	Assembly			0			
2	-06-140	Element Flange	316L		4			
3	-05-212	Channel	316L		4			
4	-05-213	FB	316L		8			
5	-06-013	Element Holder	316L		4			
6	-07-157	Connecting Block	316L		2			
7	-08-140	Aeration Flange	316L		1			
8	-10-110	Diffuser	PP	ANSI B16.5 Class150 2B	1			
9	-05-226-01	Bracket	316L		4			
10	-05-226-02	Bracket	316L		4			
11	-10-080	Permeate Manifold	PP	ANSI B16.5 Class150 3B	4			
12	-05-220	Side Panel	316L		8			
13	-10-083	Blind Flange	PP	ANSI B16.5 Class150 3B (with gasket)	2			
14	-10-084	Gasket #2	EPDM	3B	6			
15		Tube	PU		400			
16		Element	ABS	TSP-50150	400			
17	-07-157	cover	316L		2			
18	-06-006	Rubber	EPDM		8			
19	-05-435	Angle	316L		4			
20	-08-010	Comb holder	316L		4			
21	-08-006	Bracket	316L		8			
22	-08-011	Comb	EPDM		4			



Part of connect for guide (detail)

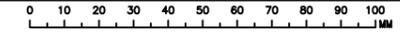


23	-10-021	Center Bracket	316L		4			
24	-10-094	Gasket #2	EPDM	2B	2			

APPROVED		TORAY INDUSTRIES, INC.	
PROJECT MANAGER		JAPAN	
MECHANICAL		SCALE 1/15	DATE 2014.2.28
INSTRUMENTAL		DRAWN J.Itakura	DESIGNED Y.Watanabe
ELECTRICAL		CHECKED K.Sakai	APPROVED K.Yokogawa
ENG. DEPT. MANAGER			

ASSEMBLY	
TMR140-400DWAP316L	
EBL140-100WAP	
ABL-200W2AP	
ORDER No.	DRWG.No.
	SS-10-145-1
REV.	ISSUED TO

LET	REVISION	DATE	BY	APPROVED



REF.DWG.NO.	TITLE OF REF.DWG.
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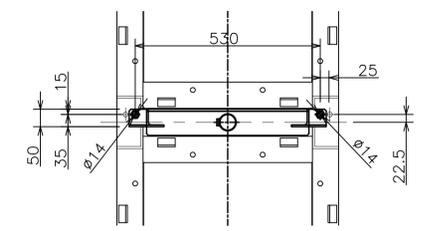
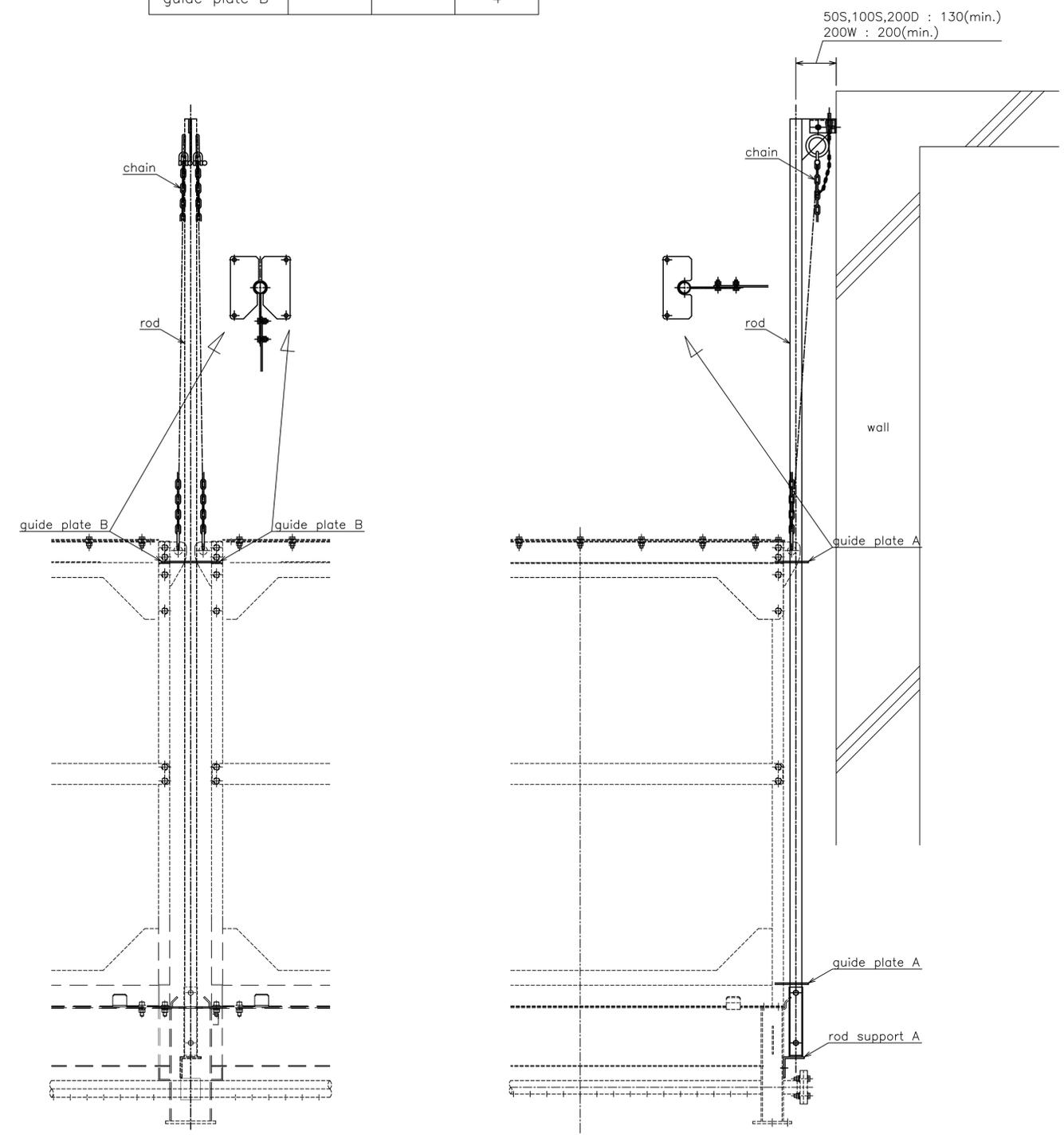
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# CONFIDENTIAL REFERENCE

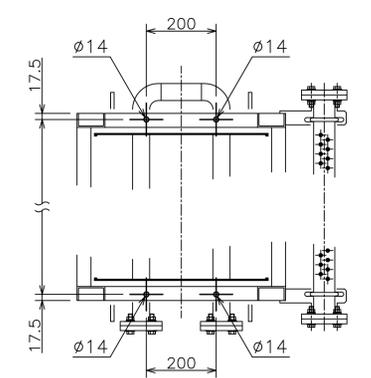
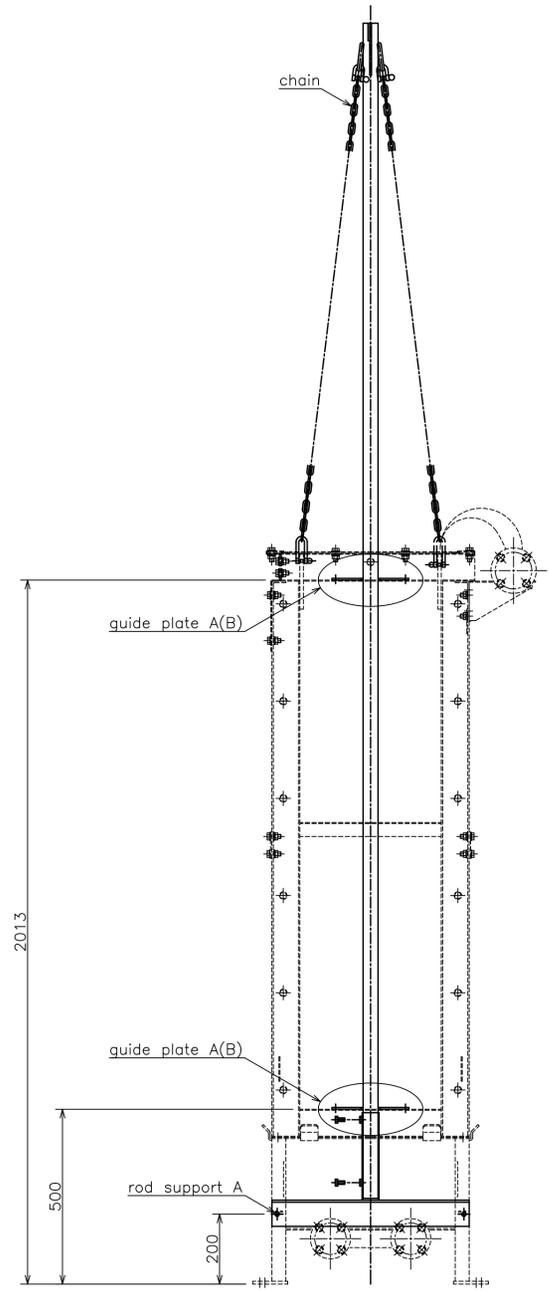
List of parts number

Type of module	50S 100S	200D	200W
guide rod	2	2	3
rod support A	2	2	2
rod support B	-	-	1
guide plate A	4	8	4
guide plate B	-	-	4

This drawing is for reference and actual situation surrounding the module(s) such as distance to the wall should be taken into consideration when designing and installing this system.



Bolt-hole fixing rod support B (200W)



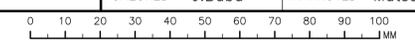
Bolt-hole fixing guide plate A

Center rod (200W)

REF.DWG.NO.	TITLE OF REF.DWG.

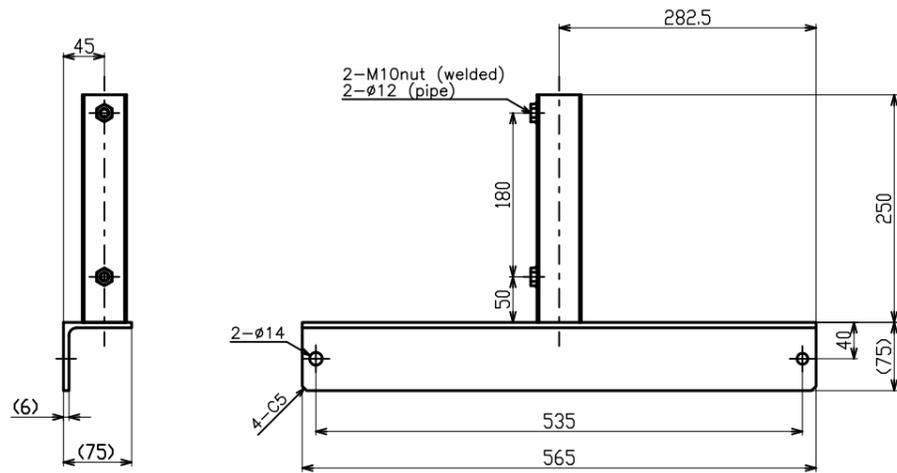
LET	ABL	REVISION	DATE	BY	APPROVED
			15.3.13	Itakura	Baba

APPROVED		TORAY INDUSTRIES, INC.		TMR140 series	
PROJECT MANAGER		MF & UF Membrane Products Dept.			
MECHANICAL		SCALE	Free	DATE	2015.3.13
INSTRUMENTAL				Guide Rod Assembly	
ELECTRICAL		DRAWN	J.Itakura	DESIGNED	Ichinose
ENG.DEPT MANAGER		CHECKED	J.Baba	APPROVED	Matsuka
		ORDER No.		DRWG.No.	
				SS-07-126	REV. $\diamond$

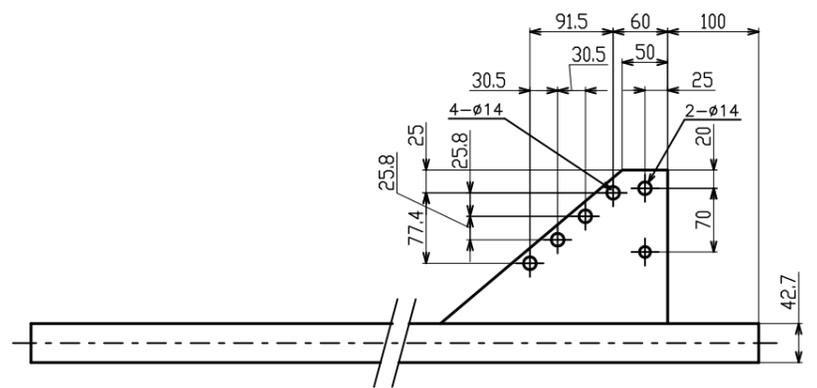


**CONFIDENTIAL REFERENCE**

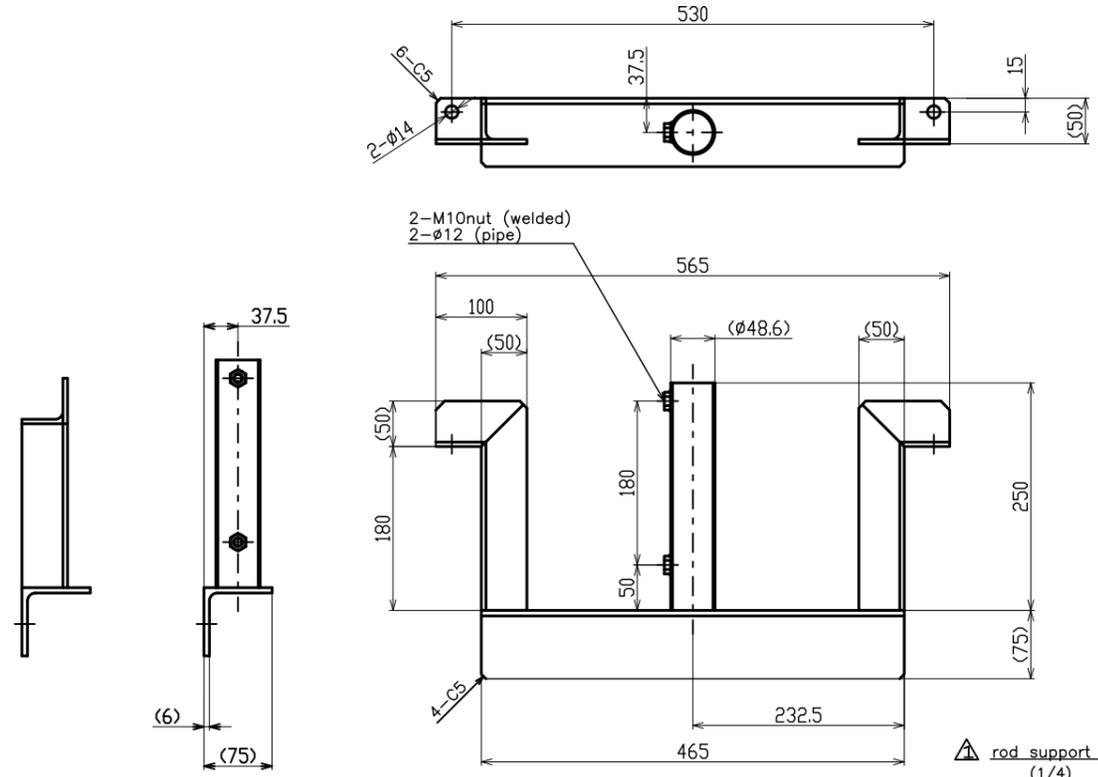
This drawing is for reference and actual situation surrounding the module(s) such as distance to the wall should be taken into consideration when designing and installing this system.



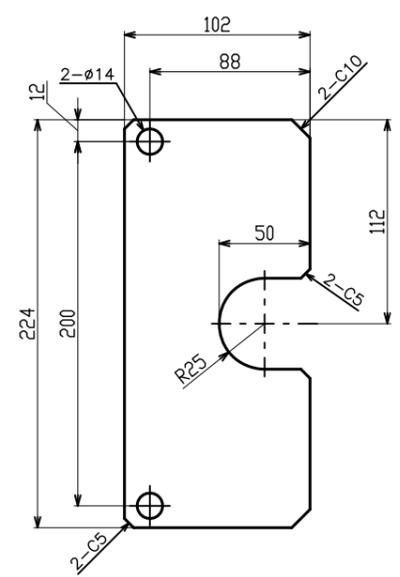
**rod support A**  
 (1/4)  
 304SS, ANSI 1 1/2(DN40)Sch5S  
 OD48.3mm, ID45mm  
 304SS, L72xt6  
 304SS, M10nut



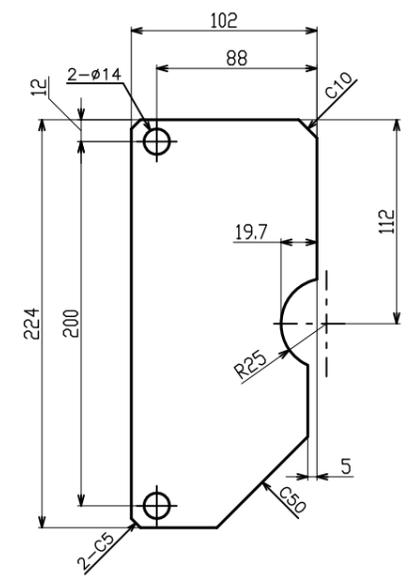
**guide rod**  
 (1/4)  
 304SS, ANSI 1 1/4(DN32)  
 OD42.2mm  
 304SS, t5



**rod support B**  
 (1/4)  
 304SS, ANSI 1 1/2(DN40)Sch5S  
 OD48.3mm, ID45mm  
 304SS, L72xt6  
 304SS, L50xt5  
 304SS, M10nut



**guide plate A**  
 (1/2)  
 304SS, t5



**guide plate B**  
 (1/2)  
 304SS, t5

List of parts number

Type of module	50S 100S	200D	200W
guide rod	2	2	3
rod support A	2	2	2
rod support B	-	-	1
guide plate A	4	8	4
guide plate B	-	-	4

Remarks

- (1) Weld shall be fillet welded.
- (2) Burr and weld flash shall be scoured away.

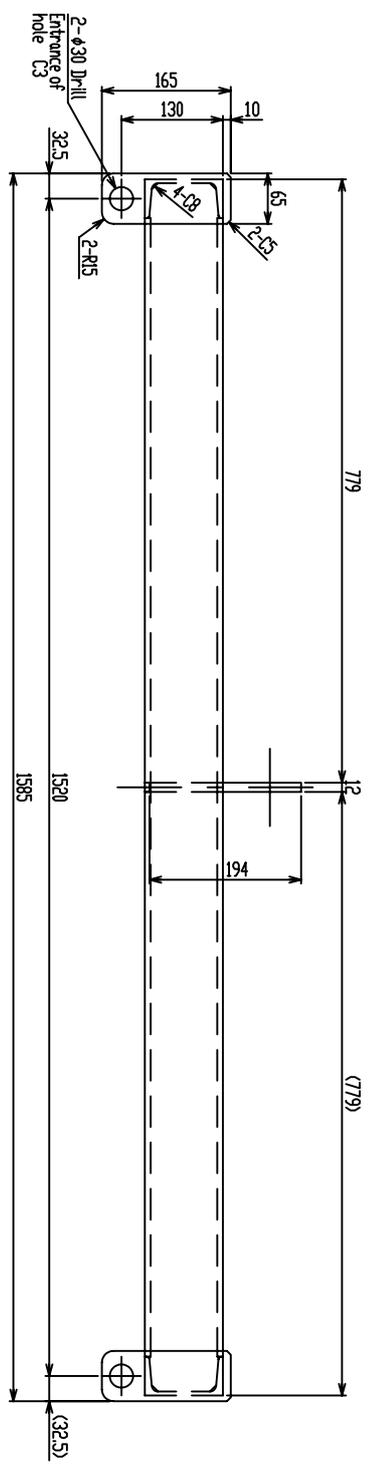
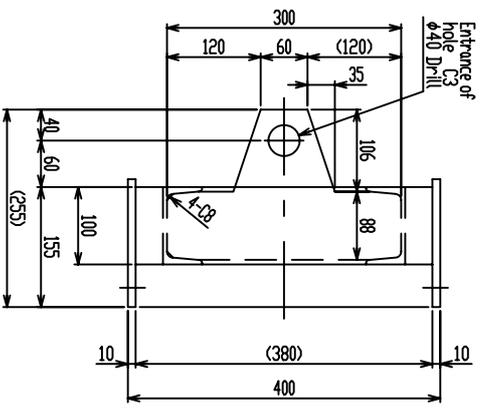
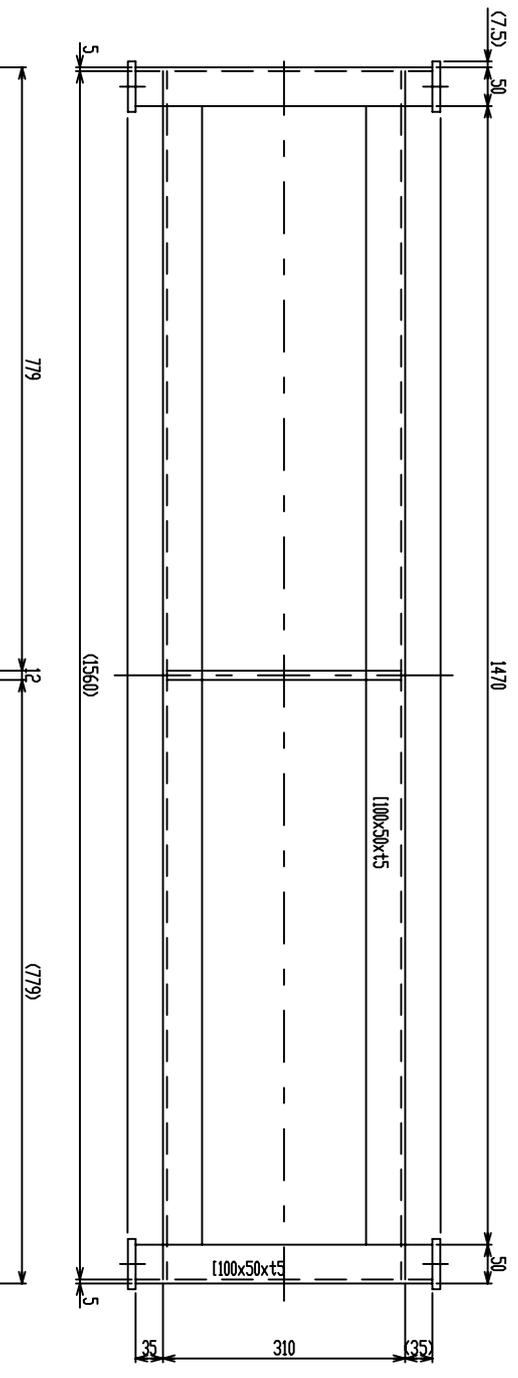
APPROVED	TORAY INDUSTRIES, INC.		TMR140 series	
PROJECT MANAGER	JAPAN		Guide Rod, Guide Plate, Rod Support	
MECHANICAL	SCALE 1/2, 1/4	DATE 2007.03.21	ORDER No.	DRWG.No.
INSTRUMENTAL	DRAWN Sakai	DESIGNED Ichinose	SS-07-125	REV.
ELECTRICAL	CHECKED Okada	APPROVED Matsuka		
ENG. DEPT. MANAGER				

rod support B	15.3.13	Itakura	Baba
LET	REVISION	DATE	BY APPROVED

REF.DWG.NO.	TITLE OF REF.DWG.
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NO. DRAWING NAME MATL. SPEC. Q1 Q2 Q3 Q4



1

- 1. Composed of Welding
- 2. with  $\frac{1}{8}$ " to be weld unless direction
- 3. Welding Surface to be smooth with G finish
- 4. Welded parts to be washed with acid
- 5. All Corner Chamfering C0.2~0.3
- 6. Weight : 41 kg f

PROJECT NUMBER	APPROVED	TORAY INDUSTRIES, INC. MF & UF Membrane Products Dept.	SCALE	1/5	DATE	'07-9-7	ORDER No.	TRR140-100S, TRR140-200D
MECHANICAL		<b>TORAY</b>	DRAWN	F. NAGATA	DESIGNED	H. OKADA	DRAWING No.	SS-07-128
ELECTRICAL			CHECKED	M. CHINOSE	APPROVED	N. MATSUKA	REV.	
INSTRUMENTAL							ISSUED TO	
REVISION								
LET								
REF. DRAWING								
TITLE OF DRAWING								

December 13<sup>th</sup>, 2011

The paper filtration test measurement procedure

1. Make a filter paper folded (Fig 1). Use filter paper equivalent to No.5C which has a diameter of 185mm (See below tables for reference.)



Fig 1. Filter paper folded

2. Set the filter paper onto a funnel.
3. Prepare 50mL of activated sludge in a measuring cylinder.
4. Pour 50mL of the sludge into the filter paper, and start measuring filtration time.
5. After 5 minutes, check the filtration volume.

<Criteria>

- More than 10 mL: Good filterability
- 5~10 mL: Subtle
- Less than 5 mL: Bad filterability

6. Additionally it is advisable to check the turbidity and/or TOC (Total Organic Carbon) of the filtrated water which can be an indicator of membrane foulant such as so-called EPC. Measure it routinely and check its trend.

Standards of filter paper

Used by TORAY	JIS P 3801	ASTM E832-81
No.5C	5C	ClassG

Typical specifications of the filter paper

	No.5C
Mass (g/m <sup>2</sup> )	118
Thickness (mm)	0.22
Permeated particle size (μm)	1
Catching efficiency (0.3 μmDOP%)	93
Ash (%)	0.01